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REPORT

OF THE

COMMITTEE FOR PLANNING MEASURES AGAINST FLOODS AND SIMILAR CALAMITIES IN DELHI

NEW DELHI
FEBRUARY 25, 1959

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SECTION I.

INTRODUCTION

1.1 Flooding of large parts of the Capital during the monsoon has been quite a common occurrence for a number of years. The all-time record of rainfall of more than 10·5″ in 24 hours, with a maximum intensity of 2·8″ in one hour, on 20th and 21st July 1958 flooded large areas in the capital, causing damage to some roads and buildings and paralysing communications. The Prime Minister called a meeting on 23rd July of the Ministers concerned, the Mayor of Delhi and other civil and military officers concerned to consider the situation that had arisen and, after discussions, appointed a committee for planning measures against floods and similar calamaties in Delhi. The composition of the committee was :—

1. Shri K. C. Reddy, Minister for W.H.& S. (*Chairman*)
2. Secretary, Ministry of Rehabilitation.
3. Secretary, Ministry of Health.
4. Chief Commissioner, Delhi.
5. Commissioner, Delhi Corporation.
6. Chief Engineer, C.P.W.D.
7. Financial Adviser, Ministry of W.H.&S.
8. Chairman, Town Planning Organisation.
9. A representative of the Central Water & Power Commission.
10. Drainage Engineer, Delhi Corporation.
11. Maj. Genl. R.E. Aserappa, Engineer-in-Chief.
12. Shri M. R. Sachdev, Secretary, Ministry of W.H.&S. (*Convenor*)

1.2 The Committee co-opted Mr. Walter George, a practising architect, as its member and also invited Shri Karnail Singh, Member, Railway Board, to assist the committee in its deliberations from time to time. Representatives of the Punjab and U.P. Irrigation Departments were also associated with the Committee's deliberations.

1.3 The terms of reference were :—

1. to consider protective measures from consequences of floods, heavy rains, etc. ;
2. to examine the adequacy of existing drainage and sewerage systems and to suggest improvements ;
3. to go into the problem of water-logging in low-lying land and sub-soil water ;
4. to examine the bridges, bunds, etc., from the structural point of view ; and
5. to look into the matter relating to equipment, such as pumps, etc., necessary to deal with emergencies.

The Committee was also required to "take suitable steps to implement the decisions taken ".

1.4 The Committee held 12 meetings in all. It appointed two Technical Sub-committees—one to assess the damage due to the unprecedented rain and carry out emergent repairs, wherever necessary, and the other to suggest short-term and long-term remedial measures. The emergent works, such as closing of breaches, sealing of possible inlets of water into buildings in low-lying areas, removal of obstructions and immediate repairs to banks of nallahs, were carried out by the various agencies, namely, the Central Public Works Department and the Corporation, and these are detailed in Appendix II.

1.5 At the instance of the Committee, special units were set up under the Central Public Works Department, the Central Water and Power Commission and the Corporation to investigate deficiencies in the existing drainage and sewerage systems. As a first step, the Committee collected the necessary data regarding intensity and duration of rainfall and contour plans for the entire area, to enable these agencies to proceed with their investigations. Their detailed reports, based on the preliminary survey, will be found at Appendices III, IV and V. The Ad Hoc Committee on Sub-soil Water has also completed its study of the causes of rise in subsoil water, and has suggested suitable remedial measures. The conclusions and the recommendations of the Ad Hoc Committee are summarised in section 4 of this report.

Information about floods is at present received from the Punjab authorities when the flood passes over Tajewala. The floods get considerably affected during travel from Tajewala to Delhi due to valley storages on the way as well as inflow due to rainfall over the intervening catchment. As such, from the information received from Tajewala, the flood levels at Delhi cannot be forecast properly. The Committee has, therefore, accepted the necessity of setting up a Flood Forecasting Unit in the Central Water and Power Commission. With flood forecasting studies carried out by this unit, it will be possible to forecast flood stages and their time of arrival at Delhi more accurately.

1.6 The terms of reference have been regrouped under the following heads :—

(*a*) Stormwater drainage.

(*b*) Sewerage.

(*c*) Problem of sub-soil water.

(*d*) Flood protection works.

(*e*) Equipment needed to deal with emergencies.

(*f*) Administrative and financial arrangements.

1.7 The Committee submitted an interim report in August, 1958 (App. I). The recommendations then made have been reviewed and the final findings and recommendations are incorporated in this report. The report has been divided into seven sections. Sections 2 to 6 deal with the terms of reference, as referred to in paragraph 1·6. The seventh section relates to financial and administrative matters. The report ends with a summary of recommendations.

SECTION 2.

STORMWATER DRAINAGE

2.1 The efficiency of a stormwater drainage system depends upon the rapidity with which rainwater can be drained away. The size of stormwater drains is determined primarily by the rate of rainfall expected, the probable run-off and the available slopes for the drains. The first problem is, therefore, to examine the intensity of rainfall for which the drainage system should be designed. For this purpose, it will be convenient to consider the urban and rural areas separately.

2.2 *The Urban Areas.*—On grounds of economy, no drainage system is designed to meet the heaviest anticipated rainfall. Further, a drainage system designed for a very high intensity cannot function efficiently under normal rainfall conditions. Therefore, a decision has to be taken on the period of recurrence of storms for which the stormwater drains are to be designed. The Technical Sub-Committee studied the rainfall data from 1845 to 1958 and also the intensity, the duration and the frequency relation of rainfall for the period from 1946 to 1955. After a careful study of the data available, the Technical Sub-Committee recommended that it should be enough if the drainage system were to be remodelled for an intensity of rainfall likely to occur once in two years, which is 1.65″ for one hour's duration. The Committee accepts the recommendations of the Technical Sub-Committee that the existing drainage system should be remodelled, wherever necessary, to cater for a storm of frequency of once in two years.

While accepting these recommendations, the Committee has not lost sight of the abnormally high intensity of rainfall received in New Delhi on the night between 20th and 21st July 1958. Some temporary flooding due to higher intensities of rainfall will be inevitable even after the remodelling of the drainage system has been carried out. When the suggested improvements to the drainage system have been made, it is anticipated that normally there will be no flooding of buildings, but special precautions should be taken to protect important buildings from flooding due to a cloudburst of the type that was experienced on the night of 20th and 21st July, 1958.

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2.3 *The Rural Areas.*— The rural areas consist of villages surrounded by vast tracts of agricultural land drained by natural water courses. The villages are normally located on local mounds and when floods occur, only the cultivated land gets submerged. While temporary flooding will not matter in the case of rural areas, flooding for longer durations can be very detrimental to crops. The adequacy of the drainage in the rural areas has to be examined from this point of view.

After considering the suggestions made by the C.W. & P.C., the Technical Sub-Committee of this Committee has recommended that the drainage system for the rural areas of Delhi should be so designed as to restrict flooding to a maximum period of 3 days with a return period of 5 years. The maximum 3 days' precipitation likely to occur once in 5 years is 8.2″, which works out to a run-off of about 10 cusecs per sq. mile of catchment area.

The Committee accepts the recommendation of the Technical Sub-Committee that the remodelling of rural drainage should be carried out on the basis of this run-off of 10 cusecs per sq. mile of catchment area. This figure may be increased suitably for the hilly portion of the catchment.

2.4 Based on natural topography, the Delhi State has been divided into the following 4 major catchments or "Blocks" for purposes of drainage.

1. The catchment of the Barapulla Nalla.
2. The catchment of the Najafgarh Nalla.
3. The catchment of the City Ditch.
4. Shahdara Area.

The catchment of the Barapulla Nalla covers New Delhi area and extends to the Air Firing Range at Tilpat in the south. The Najafgarh catchment consists of the rural area on the west and the north of Delhi. The City Ditch drains the Delhi City area. Plan No. I shows these four catchments.

2.5 The New Delhi area forms the most important part of the Barapulla catchment. A survey of the drainage system of the New Delhi area was made by the C.P.W.D. while exploring the means of lowering the subsoil water table. In respect of the Najafgarh catchment, the Central Water and Power Commission is already seized of the problem. As regards the Delhi City and Shahdara, the Delhi Municipal Corporation has collected the preliminary data to enable it to proceed with the investigation.

2.6 The Committee, therefore, desired that the investigations on the drainage and sewerage of Block 1 should be undertaken by the Central Public Works Department while the C.W. & P.C. should take up the investigation of Block 2. The Corporation was entrusted with the task of investigating the drainage and sewerage systems in Blocks 3 & 4. On the basis of sample surveys and from a study of topographical maps carried out, the deficiencies in the existing drainage and sewerage arrangements have been highlighted by these investigating agencies. The causes of flooding and the remedial measures are also detailed in the reports received from them, which form Appendices III to V to this report. These are summarised below :—

BLOCK I (CATCHMENT OF THE BARAPULLA NALLA).

2.7 This comprises an area of 40,700 acres. New Delhi is the most important part of this catchment. It also consists of new colonies in the south. The entire stormwater of this catchment drains into the Jamuna. The main outfall channels are the Barapulla Nalla, the Friends' Colony Nalla, the Sunder Nagar Drain, the Exhibition Nalla and the nalla through the Indraprastha Estate (*Vide* Plan 2).

2.8 *Unbuilt and Rural Areas.*—These areas, which are mostly to the south of the Capital, have a fairly good slope and are rocky in small portions. Much of these comprise cultivated land. Due to the good slope, there is hardly any complaint of flooding in this area.

2.9 *Built-Up Areas.*—This area consists of New Delhi as it existed prior to 1939 and also the colonies on the south that have been developed since then. The drainage system here consists of primary drains in the form of surface pitched drains, emptying into covered barrels. These barrels discharge into outfall nallas which join the river at suitable points. The drainage system of most of the areas built prior to 1939 was designed on the basis of 1/4" run-off, while the areas developed after 1939 are on the basis of ½" to 1" run-off.

2.10 *Pre*-1939 *New Delhi* (See Plan 2).—The major complaint of flooding, as a result of the record rainfall of 20th and 21st July 1958, was from the low-lying areas, like Gole Market, Fire Brigade Lane, Parliament Street, parts of Ashok Road, Talkatora Road, Old Mill Road, Raisina Road, Queen Victoria Road, Park Road, King Edward Road and the Central Vista. Flooding also occurred in the Krishi Bhavan on the Queen Victoria Road, the All India Radio building on Parliament Street, and the Telephone Exchange building in Connaught Place, resulting in the dislocation of telephone communications. The depression under the Minto Road Bridge was under 10' to 12' of water, cutting off communications between Old Delhi and New Delhi. For further details of the areas flooded, a reference may be made to the First Report and its Annexure IV (Appendix I). Studies by the Central Public Works Department have indicated that the cause of this heavy flooding is the poor interception and the inadequate capacity of the existing drains.

2.11 *Interception.*—Interception is the arrangement for conducting the rainwater into drains. In the case of roads, this is effected by grating provided on the road edges. According to the report of the C.P.W.D., the existing interception arrangements are inadequate. The number of gully gratings along the roads are insufficient and, in certain cases, gratings are provided only on one side of the road. Pipe outlets are only 4″ in diameter and are susceptible to constant choking. Road berms and lawns do not have proper slopes, with the result that, in the case of lawns, water stagnates and, in the case of road berms, the rainwater finds its way to the road, instead of to the drains direct. As a result, rainwater flows along the roads, stagnates at roundabouts and enters low-lying areas, thereby flooding them. To prevent such flooding caused by poor interception, the following remedial measures have been suggested:

(*a*) Providing additional gratings all along the roads.
(*b*) Increasing the size of outlet pipes from 4″ to 6″ diameter.
(*c*) Regrading berms and lawns wherever necessary.
(*d*) Improving the interception arrangements near roundabouts by increasing the area of gully gratings and using combination gratings with vertical and horizontal openings.

It has been estimated that the cost of these improvements would be of the order of Rs. 20 lakhs.

INADEQUACY OF THE DRAINAGE SYSTEM

2.12 It was brought to the notice of the Committee that the Delhi Town Planning Committee had recommended in 1913 that the stormwater drainage system for the Capital should be designed for 1/2″ run off for the built-up areas and 1″ for the ridge areas. Though no reason could be traced for not following these recommendations, it is observed from the estimates for the stormwater drainage prepared in 1918 that the system was actually designed for a run-off of 1/4″ for built-up areas, excepting the Secretariat buildings and the then Viceregal Estate, for which 1″ run off was adopted.

2.13 The Committee, as stated earlier, has accepted the recommendations of the Technical Sub-Committee that it would be enough to design the drainage system for a storm of frequency of once in two years. The Committee has also accepted the recommendation of the Technical Sub-Committee that the drainage system should be remodelled for a run-off based on the rational method of design for stormwater drains and not on any *ad hoc* basis. In other words, the run-off should be correlated to the period of concentration and the nature of the catchment, giving due consideration to built-up areas, roads, open spaces, etc. This has been explained in detail in Appendix III. Based on this decision, it is reported that the main drains in New Delhi should be capable of taking 1/2″ run-off while the branch drains should be designed for a greater run-off. This is the guiding principle in suggesting suitable measures for increasing the capacity of the drainage system of the built-up areas in Block No. 1.

2.14 There are 16 main drains in the pre-1939 New Delhi. Of these, 11 join up to form 3 barrels, which meet at "Q" point (at the junction of York Road and Prithviraj Road). From this point, an outfall channel, which is also a covered barrel, takes the entire discharge into the Sonehripul Nalla. This nalla falls into the Barapulla Nalla, which joins the river Jamuna near Okhla. The remaining 5 drains have other outfalls which also ultimately discharge into the river. It will thus be observed that the major portion of the stormwater of pre-1939 colonies goes to "Q" point (*vide* Plan No. 2).

2.15 The drainage system of the pre-1939 New Delhi, has, therefore, to be augmented to take the increased run-off. The improvements will take the shape of enlarging open branch drains, laying of additional branch drains where they do not exist, and duplicating the main barrels. Based on a sample survey, the Central Public Works Department have now estimated the cost of remodelling of the 16 main drains, including the laterals, at Rs. 1·39 crores.

2.16 It was also brought to notice of the Committee that the outfall channel from " Q" point was not capable of taking even 1/4" run-off in a third of its length. This is one of the bottlenecks in the existing drainage system and should receive immediate attention. The cost of augmenting the capacity of this drain to 1/2" run-off has been estimated at Rs. 27 lacs.

COLONIES IN BLOCK I BUILT AFTER 1939

2.17 The internal drainage system of these colonies is generally designed for an *ad hoc* run off varying from 1/2" to 1". This is generally adequate. Complaints, however, came from some of the new colonies mentioned below:—

Nizamuddin.—This colony drains into the Barapulla Nalla. Detailed hydrological study of the Nizamuddin drainage system shows that when the Barapulla Nalla flows to capacity, its water level is too high to permit of gravity flow from Nizamuddin. It is, therefore, necessary to provide permanent pumping arrangements here as there is no possibility of deepening the Barapulla Nalla. As pumping would involve a recurring expenditure, this should be resorted to after the possibility of draining this area by gravity directly into the river has been ruled out as a result of further investigations.

Jor Bagh.—Part of Jor Bagh drains into the Kerbala Drain. During heavy rainfalls, however, the water level in this drain rises above the Jor Bagh level, causing backing up in the Jor Bagh drains. In order to remedy this, it is necessary to deepen the Kerbala Drain.

Golf Link Colony.—The drainage of this colony discharges directly into outfall channel No. 3. As stated in paragraph 2.16, this outfall channel is already overloaded, as a result of which it is not able to drain this colony. The remedy, therefore, lies in connecting this colony to an alternative outfall. It is now proposed to connect it directly to the Sonehripul Nalla at a point 1000′ downstream of the Lodhi Road bridge. This outfall will also function efficiently only after the necessary improvements to the nalla, sugested in para 2·20, have been carried out.

Lajpatnagar and Friends Colony.—Lajpatnagar is drained by the Lajpatnagar Nalla. This nalla has an inadequate capacity, as a result of which it overflows and floods parts of the colony. Also, the waterways of the railway and road culverts over this nalla are restricted, and this aggravates the problem. It is, therefore, necessary to remodel both the nalla and the railway culvert. Similar remodelling is necessary in the case of the Friends' Colony Nalla and some of the road culverts over it.

2 18 The cost of the above improvements to the post-1939 colonies, excluding the cost of remodelling the Lajpatnagar Nalla and the Friends' Colony Nalla and of providing pumping arrangements for Nizamuddin, is estimated, at Rs. 1,76,000/-. The cost of remodelling the nalla is included in the cost of improvements necessary to nallas described in paragraph 2·20. The cost of providing pumping arrangements in Nizamuddin is included in the cost of improvements to low-lying pockets described in paragraph 2·19.

2.19 There are a number of low-lying pockets in the whole of Block 1, that cannot drain by gravity. These are Nizamuddin, Indraprastha Estate and the adjoining areas and the depressions under the Minto Road Bridge and the Hardinge Bridge. The problem of Nizamuddin has already been discussed in paragraph 2·17 and the cost of providing pumping arrangements for this colony is estimated at Rs. 7,20,000/-. The cost of providing pumping arrangements under the Minto Road Bridge is estimred at Rs. 50,000/ and a similar provision would be necessary for the Hardinge

Bridge. The total cost of providing pumping arrangements for Nizamuddin, the Minto Bridge and the Hardinge Bridge is thus Rs. 8·2 lacs. As regards the Indraprastha Estate and the adjoining areas, it is reported that two schemes for the disposal of stormwater by pumping have been sanctioned by the Government of India. The Committee would recommend their early implementation.

2.20 *Nallas.*—The nallas draining Block I are the Barapulla Nalla and its tributaries, the Friends' Colony Nalla, the Sunder Nagar Nalla and the nalla running through the Exhibition Grounds. Of these, the largest, and by far the most important, is the Barapulla Nalla. Its major tributaries are the Kushak Nalla, the Sonehripul Nalla, the Chiragh Delhi Nalla and the Lajpatnagar Nalla. All these nallas are silted up and need immediate desilting. The Lajpatnagar Nalla and the Friends' Colony Nalla have inadequate capacity and will have to be remodelled as they overflow their banks and flood the neighbouring colonies. The Kushak Nalla also needs regrading in its upper reaches.

Bridges, like the railway bridge over the Lajpatnagar Nalla, some of the road bridges over the Friends' Colony Nalla, the Mathura Road Bridge and the Barapulla Bridge over the Barapulla Nalla, have restricted waterways, as a result of which the water level in these nallas rises unduly and causes tide-locking of the branch drains. It is, therefore, necessary to remodel these bridges. The total cost of these improvements is estimated at Rs. 40,68,000/-.

2.21 Summing up, the works required to improve the drainage system of Block I are:—

(*a*) Improving the existing interception arrangements of stormwater in the pre-1939 New Delhi. This is estimated to cost Rs. 20 lacs (*Vide* Paragraph 2.11).

(*b*) Englarging the existing underground drains in the pre-1939 New Delhi to take an increased run-off of 1/2". This is estimated to cost Rs. 1.40 crores (*Vide* Paragraph 2.15).

(*c*) Improving the outfall conditions of connecting drains in respect of the post-1939 colonies. This is estimated to cost Rs. 1,76,000/- (*Vide* Paragraph 2.18).

(*d*) Desilting and re-sectioning of major nallas, including remodelling of road and railway bridges, wherever necessary. This is estimated to cost Rs. 40.68 lacs.

(*e*) Providing pumping arrangements to take care of low pockets which cannot be drained by gravity (excluding the Indraprastha Estate and the adjoining areas). This is estimated to cost Rs. 8,20,000/- (*Vide* Paragraph 2.19).

(For details see Appendix III).

The Committee recommends that, as a first step, the bottlenecks, mentioned in paragraph 2.16 and clauses (*a*), (*c*), (*d*) and (*e*) above, should be removed and the performance of the drainage system carefully watched. On the basis of observations then made, further augmentation of the drainage system, as envisaged in clause (*b*) above, should be taken up.

2.22 The Committee was informed that two estimates relating to Block I—one for providing relief drains in the Fire Brigade Lane and another for the regarding of the Kushak Nalla in its upper reaches—have been submitted to the Government of India for sanction and provision of funds. The Committee would recommend immediate sanction of these estimates.

BLOCK NO. II. (NAJAFGARH CATCHMENT)

2.23 The Najafgarh Drain, together with its branch drains, serves a catchment of 508 sq. miles. It starts from a jheel situated near Najafgarh village about 20 miles south-west of Delhi city. The drain is 31 miles long and, in its tail reaches, passes through Delhi urban areas and outfalls into the Jamuna just below the Wazirabad Pumping Station. The drain also acts as the main drainage outlet for the Daryala Nalla and other city stormwater drains which carry sewage as well (*Vide* Plans Nos. 1 & 2).

2.24 The catchment of this nalla can also be divided into two parts—the urban and the rural. The urban areas are drained by the Daryala Nalla and other nallas serving the Western Extension Area of Delhi and the Palam Drain serving the Cantonment area. There has been no complaint of flooding from the Cantonment area, mainly on account of its high contours. The catchment of the Daryala Nalla has, however, been subject to heavy flooding during the rains of July 1958.

2.25 The flooding was more pronounced near the Rohtak Road where many of the buildings on either side of the drain were under knee-deep water. The total catchment of this drain is 4·6 sq. miles. Based on a rational method of design of stormwater drainage, the run-off at the railway bridge across this drain near the Rohtak Road from its catchment has been worked out as 2,065 cusecs. The railway bridge across this drain near the Rohtak Road has been found to be inadequate to take this discharge, as it has a capacity of only 900 cusecs. This was one of the causes of flooding of this area.

2.26 At the instance of the Committee, the Railway authorities have already proposed an additional span to the existing bridge to take the full run-off. The cost of its remodelling has been estimated at Rs. 2 lacs. The Committee recommends the completion of this work before the next monsoon.

2.27 The Committee was also informed that certain areas on either side of the nalla could not drain into the nalla when it was running full. The drainage of such low pockets can be effected only by pumping. The Corporation authorities propose to deal with these pockets by installing portable pumps available with them. The Committee recommends that timely action should be taken to place the pumps in position before the next monsoon.

2.28 It was also brought to the notice of the Committee that the stormwater drain recently constructed from Model Town to the Najafgarh Drain, which takes water from an area of about 3,500 acres, gets tide-locked and fails to function when the river is in spate. In order to relieve this condition, it is necessary to provide a battery of high-capacity low-head pumps and to instal flood gates near the Shah Alam Bridge on Kingsway. The stormwater drains from Hari Nagar and Mehrauli also require to be improved. These improvements are estimated to cost Rs. 20 lacs.

2.29 *Rural Areas.*—The stormwater from Alipore and Najafgarh blocks of Delhi State drains partly into the Najafgarh Jheel and partly into the Najafgarh Drain. The water from the Jheel ultimately flows into the Jamuna through the drain, when the level in the Jheel rises above a certain limit. Higher water level in the Jheel results in the submersion of large tracts of cultivable land.

2.30 As a result of the heavy rainfall of July 1958, the water level in the Jheel rose to R. L. 692·4, submerging an area of 14,400 acres. This is reported to be the maximum rise for a number of years. The villages subject to water-logging are listed in Appendix VI.

2.31 At the instance of the Committee, the C.W. & P.C. have carried out a preliminary study of the drainage problem of this catchment, based on whatever maps and data were available, and their report will be found at Appendix IV. A summary of the findings and the recommendations is given below :—

2.32 The area around Najafgarh village in the Delhi State, which suffers from inundation and water-logging, comprises (*i*) the existing Najafgarh Jheel area, and (*ii*) the part basins of the Mangeshpur and Nangloi Drains lying within the Delhi State.

2.33 The Najafgarh Jheel proper is a natural saucer-shaped depression situated near the Najafgrah village about 20 miles south-east of Delhi. The Jheel is filled during the monsoon by its own independent catchment of about 350 sq. miles, lying partly in the Delhi State and partly in the Punjab. In Gurgaon district, within this catchment, there are some existing irrigation reservoirs which hold up water during monsoons for irrigation purposes. After these reservoirs are full, surplus water spills into the Jheel. Before the Rabi sowing starts, the remaining water within the reservoir is also allowed to escape into the Jheel.

2.34 The Jheel has only one outlet, namely, the Najafgarh Drain. The drain is joined on its left by the Mangeshpur and Nangloi Drains and, on the right, by hill streams from the Punjab and the Delhi State. In the tail reach within the Delhi city area, the drain also acts as the main drainage outlet for the Daryala Nalla and other city stormwater drains, which carry city sewage water as well.

2.35 The Mangeshpur Drain rises in the Punjab and has various tributaries within the Punjab and the Delhi State. Its entire catchment, including that of the tributaries up to its outfall into the Najafgarh Drain, is about 203 sq. miles. The calculated maximum flood discharge at the outfall works out approximately to 1,254 cusecs, whereas the present carrying capacity of the drain is hardly 334 cusecs.

2.36 The Nangloi Drain, arising within the Delhi State, has an approximate catchment of about 32 sq. miles and joins the Najafgarh Drain near Nangloi Saiyadan. The maximum discharge from this catchment has been calculated to be 320 cusecs against its existing capacity of 44 cusecs only.

2.37 The hill streams from the Punjab and the Delhi State have a total catchment area of about 100 sq. miles and the maximum flood discharge has been calculated at 1,500 cusecs.

2.38 The Palam Drain has a catchment of about 4·8 sq. miles of built-up area, and the maximum flood discharge works out at approximately 2,080 cusecs.

2.39 The Daryala Nalla drains the Delhi city area, and its calculated maximum flood discharge has been reported to be approximately 2,065 cusecs.

2.40 Other city drainages, which join the Najafgarh Drain below the Daryala Nalla, have a catchment of 3·8 sq. miles of built-up area, and the maximum calculated flood discharge has been worked out approximately at 2,240 cusecs.

2.41 The Najafgarh Jheel acts as a natural drainage reservoir for the surrounding area and permits cultivation of areas on its fringes during the years when rainfall is not heavy. During heavy rainfall, however, the lake is not able to discharge its flood waters expeditiously due to the reverse slope and the limited discharging capacity of its only outlet drain, the present carrying capacity of the drain being less than a quarter of the anticipated run-off. The cultivated area round the Jheel, therefore, suffers heavily due to prolonged inundation.

2.42 The problem is further aggravated by the inundation of areas on the banks of the Mangeshpur and Nangloi Drains due to their own limited discharging capacity and poor outfall conditions obtaining in the Najafgarh Drain.

2.43 The normal tank full level within the Jheel is R.L. 690 which submerges an area of about 7,500 acres. During the years of maximum rainfall, as for instance during 1958, the maximum tank full level was R. L. 692·4, submerging an area of about 14,400 acres. The area inundated within the basin of the Mangeshpur and Nangloi Drains during the last rains was 10,000 to 15,000 acres.

2.44 The basic solution to the drainage problem of the Najafgarh area appears to lie in increasing the discharging capacity of the Najafgarh Drain so as to reduce the extent and duration of inundation.

2.45 The widening and deepening of the Najafgarh Drain is bound to be a costly affair and will also take considerable time. If the water level in the Jheel could be brought down to a level below 690, an area of about 3,000 acres could be released for Rabi cultivation earlier than now. This could be achieved by the removal of the hump and by regrading the bed of the drain in a reach of 10 miles between the Kakraula Bridge and the road bridge near Basaidarpur village (see Plan No. 1). In the reach below, regrading work was carried out during the preceding year. In addition, silt clearance of the Mangeshpur and Nangloi Drains is also necessary. The C.W. & P.C. have now estimated that this would cost Rs. 2·71 lacs. The Committee recommends the completion of this work before the next monsoons.

2.46 Substantial interim relief can be given by increasing the discharge capacity of the Najafgarh Drain so as to empty the areas under inundation below R.L. 690 and thus release an area of about 6,300 acres for Rabi cultivation. This envisages complete re-sectioning of the drain in a reach of 13 miles below the Kakraula Bridge to a width of 60 feet and slope of 1 to 10,000 against the present bed width, which varies from 20 ft to 60 ft. This involves the lowering of the existing bed by about 4′ under the existing road and rail structures in the above reach. The Railway authorities have confirmed that it will not be possible to permit any lowering of the existing bed under the railway bridges without reconstructing them. Similar information on the remaining intervening structures is not forthcoming, but it may be presumed that these will also require replacement. The cost of such widening works out to Rs. 25·93 lacs which provides for the replacement of the existing masonry structures across the drain. It will, however, be possible to dovetail the work under the immediate measure (*Vide* paragraph 2·44 above) into the present proposal. This should form the 2nd phase of the project. The Committee accepts the necessity of this work and would recommend its early implementation after necessary survey has been carried out.

2.47 A complete relief could be afforded if the rainwater is prevented from flooding the areas for long duration and the same is drained away within three to four days after the rainfall. This will release an area of about 14,400 acres within the Jheel and the area liable to floods within the basin of other inflow drains during abnormal years, like the year 1958. In ordinary years, it will protect an area of about 7,500 acres from flooding. The area thus protected would be used for Kharif and/or Rabi cultivation. Works necessary to achieve the above objectives are :—

(*i*) Provision of a catch-water drain round the Jheel.

(*ii*) Provision of a detention basin on the Palam Drain.

(*iii*) Regrading and/or diversion of the Mangeshpur and Nangloi Drains and other hill streams.

(*iv*) Thorough improvement of the Najafgarh Drain in its entire reach from the Kakraula Bridge to its outfall into the Jamuna.

The cost of these works is estimated at Rs. 1·5 crores. This includes the list of works mentioned in paragraphs 2.45 and 2.46.

2.48 While the cost of carrying out the improvements suggested above is high, it has to be weighed against the advantages that will accrue by way of more food and relief to the affected villagers. Also, as the rainfall in this area is generally short of requirements for crops, any proposal to dry up the Jheel completely may have to be linked up with schemes for irrigating this area. It is understood that proposals for irrigation schemes, in which this area is included, are under preparation by the Punjab engineers. The Committee recommends that the question of draining the Jheel completely should be examined by the C.W. & P.C. in consultation with the Ministry of Food and Agriculture.

Block No. III (City Area)

2.49 The Old City area falls in this block. The ground is generally high and allows easy drainage. The internal drainage system is a combined system and caters for both stormwater and sewage. The stormwater from this area is collected by the sewers and taken all the way to the Kilokri Pumping Station for disposal. If the stormwater is separated from the sewage, it could be easily drained straight into the Jamuna. This would relieve the strain on the already overloaded sewerage treatment plant at Okhla.

2·50 The Committee, therefore, accepted in principle the proposal that in areas with a combined system, the stormwater should be separated from the sewage.

2·51 Such a separation is bound to be difficult in intensely built-up areas, like the city areas, where the gully widths are hardly 5′ to 6′. In such areas, therefore, only partial separation is possible. At present, open drains on the road sides collect both rainwater and sullage from houses and discharge them into the combined sewers. The stormwater could be intercepted before it enters the sewers and taken through new stormwater drains, into the river Jamuna direct. For this, it will be necessary to connect independently the flow from the houses to the sewers, allowing the open drains on the road sides to collect only the rain water. The cost of such separation in the Old City area has been estimated at Rs. 30 lacs.

BLOCK NO. IV (SHAHDARA AREA)

2·52 This block comprises an area of 3,500 acres on the east bank of the Jamuna. It covers Shahdara and other colonies like Gandhi Nagar and Gita Colony. Almost the entire area is low-lying and remains water-logged for long periods in the year. Apart from this, considerable areas are also liable to flooding.

2·53 The topography of the area reveals that about 30% of it is below R.L. 655 and the remaining 70% lies between R.L. 655 and 670. The danger level of the river Jamuna near the railway bridge is 672. The highest flood level in the river, recorded at this point in 1956, was 677·3. The designed high flood level for the Shahdara Bund at this point is 678. This shows that a very large part of the Shahdara area is below the high flood level of the river and much below the highest floods experienced during the last few years. Detailed hydrological study of the Jamuna reveals that the Shahdara area can drain into it by gravity only for 31 days in the year. The problem of flooding is aggravated by the ingress of water from areas in the north. Hence large areas remain water-logged for long periods in the year.

2·54 It was brought to the notice of the Committee that in 1957, the Delhi Development Provisional Authority had appointed an *ad hoc* committee to examine *inter alia* the drainage problems of the Shahdara area. The *ad hoc* committee was of the view that it would be far better not to develop this area at all and to remove the population at present residing in that area, because they felt that the cost of development would be disproportionately high and the burden of the cost would not be bearable by the residents. It was reported by the *ad hoc* committee that the entire drainage would have to be done by pumping and the capital outlay would be about Rs. 1·81 crores.

2·55 Even if the cost of development is heavy, it would be impracticable, purely from the administrative point of view, to remove the existing population from there within any foreseeable period of time. There is also the psychological difficulty of asking masses of people to shift from one place to another, leaving their hearths and homes behind. There are other major considerations, like economic ties, proximity to work centres, etc. Considering all these difficulties, the Committee recommends that the authorities should go forward with proposals for improving the drainage of this area with a view not only to helping those who are living there but also to making it possible for other people as well to settle in the area.

2·56 The Delhi Municipal Corporation has now come up with a proposal to drain the South Shahdara area by gravity into the Jamuna. It is reported that, at a point downstream of the Okhla Weir, there is a substantial drop in the river water level. It is now proposed to examine whether advantage can be taken of this drop, and thus drain the Shahdara area by gravity at a point beyond the Weir.

2.57 The Shahdara area can be divided into North and South Shahdara, the dividing line between them being the Northern Railway line. South Shahdara includes parts of Shahdara, Gandhi Nagar, Gita Colony, etc., while North Shahdara consists of Rohtas Nagar, Luneja, Dilshad Colony, etc.

2.58 South Shahdara comprises an area of 2,000 acres. The Marginal Bund, constructed along the banks of the river, has effectively prevented the flooding of this region from the river. But this has also prevented the drainage of this area into the river. The developed areas of South Shahdara are mostly situated on comparatively high ground, excepting some parts, like Gita Colony, Gandhi Nagar, Krishna Nagar, etc. A disused channel, known as the diversion channel, prevents the natural flow of water from the higher regions to the low-lying area towards the south. The proposal now is to make use of this diversion channel as a main collecting channel by desilting it. The rainwater of the Shahdara area will be collected by subsidiary channels running north-south and will be discharged into this diversion channel. From this diversion channel, a main outlet channel will be constructed upto the Hindan Cut. Outlets exist across the Hindan Cut to allow the stormwater to pass through. It will now be necessary to enlarge these outlets to take the additional discharge that will be coming through the main outlet channel. Under this scheme, as proposed by the Corporation, no pumping will be necessary. It has been estimated by the Corporation that the cost of this scheme will be Rs. 24 lacs.

The Committee understands that the scheme formulated by the Corporation is based on a general study of the conditions at site. Detailed field survey is in progress. It is necessary that detailed investigations should be carried out before it can be confirmed that disposal of stormwater by gravity from this entire area would be possible. If, on further investigations, it is found that drainage by gravity is not possible, pumping will have to be resorted to, as a supplementary measure.

The Committee was also informed that, under the advice of the Corporation, the drainage scheme of the Rehabilitation colony of Gandhi Nagar by pumping has not been implemented. The Committee would reiterate its recommendation about the early completion of detailed investigations to confirm that the area could be drained by gravity.

2.59 Regarding Shahdara North, comprising an area of 1,500 acres, the Corporation have suggested the construction of a catchwater drain along the G.T. Road to intercept the stormwater. This will partly drain towards the river through regulators provided in the Shahdara Bund. When the river levels do not permit a gravity flow, pumping will be resorted to. A part of this water will be diverted into the disused channel across the railway line through suitable openings. The cost of this scheme, inclusive of pumping, is estimated at Rs. 18 lacs.

2.60 The total cost of these improvements to the stormwater drainage in block IV, therefore, aggregates to Rs. 42 lacs, of which Rs. 32 lacs represents the cost of internal drains and Rs. 10 lacs the cost of the outfall arrangements.

61 The Committee was also informed that the area of land lying between the Eastern Jamuna Canal, the Shahdara Bund and the Delhi Ghaziabad Road is sujbect to flooding from the three canal escapes of the Eastern Jamuna Canal. These canal escapes take the flood water from the Eastern Jamuna Canal which also acts as a drainage channel. If one or two regulators were to be built in the Shahdara Bund, the flood water from the Bankila and Gokalpur escapes could be led directly into the river. The cost of canalising and providing regulators to these escapes has been estimated at Rs. 3,71,830. The Committee understands that a part of this area is proposed for development for resettling the slum-dwellers of the Jamuna Bazar area. Before, however, this development is undertaken, the Committee recommends that this work estimated to cost about Rs. 3,71,830 should be undertaken along with other protective measures for preventing this area from being flooded. The Committee understands that all these works are provided for in the development scheme.

2.62 To sum up, the following are the works recommended for the improvement of drainage in the Delhi area :—

Block No. I.

1. Improving the existing interception arrangements of stormwater in the pre-1939 New Delhi (Paragraph 2.11).
2. Duplicating the existing underground drains in the pre-1939 New Delhi to take an increased run-off of 1/2″ against the initially designed run-off of 1/4″. (Paragraphs 2.15, 2.16 and 2.21).
3. Improving the outfall condition of connecting drains in respect of the post-1939 colonies (Paragraph 2.18).
4. Providing pumping arrangements to take care of low pockets which cannot be drained by gravity (Paragraph 2.19).
5. Desilting and resectioning of the major nallas, including remodelling of road and railway bridges, wherever necessary (Paragraph 2.20.)

Block No. II.

6. Removal of the hump and regrading the bed of the Najafgarh Drain reach of 10 miles from the Kakraula Bridge to the road bridge near Basaidarapur and silt clearance of the Mangeshpur and Nangloi Drains, as an immediate measure (Paragraph 2.45.)
7. Complete resectioning of the Najafgarh Drain in a reach of 13 miles below the Kakraula Bridge to a width of 60′ and a slope of 1 in 10,000, as an interim measure (Paragraph 2.46.)
8. Provision of a catchwater drain round the Najafgarh Jheel, provision of a detention basin on the Palam Drain regrading and/or diversion of the Mangeshpur and Nangloi Drains and other hill streams and therough improvement of the Najafgarh Drain in its entire reach from the Kakraula Bridge to the Jamuna, for complete relief (Paragraph 2.47.)

Block No. III.

9. Separating sewerage from stormwater drains in respect of the Delhi City area (Paragraph 2·51.)

Block No. IV.

10. Providing a system of internal drainage for the Shahdara area, with an independent outfall into the river at a point below the Okhla Weir (Paragraphs 2·58 and 2·59).

2·63 The improvements to the drainage of the Delhi area suggested above have been estimated to cost Rs. 4·79 crores. While it is desirable to carry out immediately all the improvements suggested the completion of all these projects is bound to take time. Therefore, the work required to be done has been subdivided into 3 phases, namely,—

(*a*) Works that should be completed before the next monsoons.

(*b*) Works of an urgent nature that should be taken up for execution as soon as the final investigations are completed.

(*c*) Remaining works envisaged in the projects.

The details of the works and their costs phase-wise will be found at Appendix VII.

CONVERSION OF SOME LOW-LYING AREAS INTO LAKES

2·64 A suggestion was also made to the Committee about the possibility of converting low-lying depressions into lakes to reduce flooding. The Lodi Gardens was considered for this purpose, but the Committee was advised that such a lake would add to the already high subsoil water table in the area. There would also be difficulty in replenishing the water in the lake during the summer months. The Committee, however, understands that the provision of a lake in the ridge area near the Kitchener Road is under the consideration of the Town Planning Organisation. The Committee recommends that this idea should be actively pursued.

MAINTENANCE

2·65 Ultimately, the efficiency of any drainage system depends, to a large extent, on the standard of maintenance. The existing standard of maintenance leaves much to be desired. In order to reap the full benefit of the proposed improvements, it is essential that the standard of maintenance of drains should be improved.

2·66 At present, the stormwater drains of the New Delhi area are maintained by the N.D.M.C. The drainage system of Old Delhi is under the maintenance of the Corporation authorities. There should be a separate set-up under the respective local bodies for efficient maintenance of these drains. In respect of the New Delhi area, the drains should be examined by the Senior Engineer of the N.D.M.C. and a report on the condition of the drains sent to the Ministry of Health/Home Affairs, through the President, N.D.M.C. Similarly, in respect of drains in the Old Delhi area, the Corporation Engineer should submit a report on their condition to the Ministry of Home Affairs, through the Commissioner of the Corporation. Similar action should be taken in respect of the Najafgarh Drain by the Delhi State P.W.D. A report will be submitted to the Ministries of Irrigation and Power and Home Affairs, through the Chief Commissioner, Delhi.

2·67 These drains should be carefully inspected by the appropriate authorities in the month of October each year. Wherever necessary, action should be taken to desilt and repair the stormwater drains, during the winter months and an inspection should again be made in the month of April, to ensure that all necessary repairs have been carried out and the drains are in good order. These reports will be sent to the appropriate authorities mentioned in paragraph 2·66. Such systematic annual inspection will ensure the efficient functioning of the stormwater drains during and after the rains.

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SECTION 3

SEWERAGE

3.1 The first outfall sewer and sewage disposal works, brought into use in 1925, were intended to meet the requirements till 1955, by which year the population served was expected to be about 4 lacs. This provision for sewerage of Delhi proved, as in the case of many other towns in India, to be quite insufficient, long before the anticipated date. Additions to the sewerage system and its disposal works, made from time to time, have not kept pace with the increase in population. The result is overloading of the trunk sewers and disposal works.

3.2 It is well known that many of the Rehabilitation colonies were built and occupied before arrangements could be completed for the disposal of human waste. Newly developed private colonies, such as the Friends' Colony, Hauz Khas and the Green Park, etc., have also not been provided with sewerage facilities. The Committee has observed that many of the new colonies recently built have no integrated sewerage system. While the absence of such a sewerage system in the case of hurriedly built rehabilitation colonies is understandable, there is no justification for sanctioning of buildings in areas which are not likely to be served by sewers in the near future. The Committee hopes that this matter will receive the attention of the appropriate authorities.

3.3 For the purpose of investigation of the sewerage system, the urban area of the Delhi State has been divided into four zones, *viz.*, the South-East Zone, the North Zone, the West Zone and the Shahdara Area. These zones have been formed on the basis of the natural topography of the land. Also, the South-East, North and West Zones are served by separate treatment plants and, therefore, form separate units. The details of the trunk sewers and the location of the treatment plants serving the different areas are shown in the plan No. 3. This report does not deal with the numerous outlying villages which will be independently dealt with by the Delhi Municipal Corporation under rural sanitation and water supply schemes.

SOUTH-EAST ZONE

3.4 This comprises an area of about 30,000 acres and includes the Civil Lines. The Old Delhi area, New Delhi and a number of outlying colonies on the south, such as Hauz Khas, Kailash, Greater Kailash, the Green Park, Kalkaji, Lajpat Nagar, Malvia Nagar, the Friends' Colony, Nizamuddin, Jangpura, and the Defence Colony, etc. The entire area has a gradual slope towards the Jamuna.

3.5 Three main trunk sewers serve this area. They are marked A, B and C in the Plan No. 3. The trunk sewers A & B start in Old Delhi, pass through New Delhi and end at the Kilokri Pumping Station. The third trunk sewer C, which starts from Vinay Nagar, also ends at the Kilokri Pumping Station. The trunk sewer C serves the areas of Vinay Nagar, Lajpat Nagar, Jangpura and Nizamuddin. The trunk sewers A & B serve the remaining areas of New Delhi to the north and the Old Delhi city area. From the Kilokri Pumping Station, the sewage is pumped into a gravity duct which carries the flow to the treatment plant at Okhla.

3.6 The trunk sewers A & B starting from Old Delhi are both over-loaded and are provided with over-flows into the stormwater drainage system. Also, there is evidence of over-loading in respect of some of the main sewers serving the New Delhi area. In order to relieve the over-loaded sewers, it is necessary to lay relief sewers. The Old Delhi city area is served by a combined system due to which stormwater also finds its way into the sewers, resulting in over-loading of the sewers. The Okhla treatment plant does not have adequate capacity to deal with the entire sewage flow and needs augmentation. Many of the outlying colonies have no sewerage system at all. The main problems of sewerage in the South-East Zone are, therefore:—

(*a*) Relieving the over-loaded branch and trunk sewers.
(*b*) Separation of sewage & stormwater in the Old Delhi city.
(*c*) Providing sewerage in the unsewered colonies.
(*d*) Augmenting the capacity of the Okhla treatment plant.

These problems are dealt with in the following paragraphs.

3.7 Out of the 11 main sewers serving the New Delhi area, the main sewer No. 2, running along Panchkuin Road, is reported to be over-loaded. It is, therefore, necessary to provide a relief sewer along this road. Similarly, the main sewers Nos. 3 and 4, both running along Ashok Road, are also reported to be over-loaded and it is necessary to have a relief sewer to reduce the load on these sewers. The position regarding the main sewer No. 5, which starts from the North Block and joins the main sewer No. 3 at the junction of Mansingh Road and Ashok Road, is also the same. Another case of over-loading is in respect of the main sewer No. 11 which serves the Lodi Colony and Jor-Bagh. There is considerable overflow through the existing manholes and, at present, a bypass has been provided into the stormwater drain. As a long-term measure, it will be necessary to provide relief sewers and also augment the pumping capacity at the Lodi Road Pumping Station. The Committee understands that a scheme for augmenting the pumping capacity is already under the consideration of the N.D.M.C. The cost of providing the relief sewers has been estimated by the C.P.W.D. to be Rs. 7 lacs. This does not cover the cost of augmenting the capacity of the Lodi Road Pumping Station, regarding which separate action is being taken by the N.D.M.C.

3.8 As already stated in paragraph 3·6, the trunk sewers starting from Old Delhi are both overloaded. At present, sewage overflows at the following 10 points from these sewers into the stormwater drains:—

(1) Sweepers' Colony near Chandrawal 2.
(2) Khyber Pass Colony.
(3) Dhobighat Colony.
(4) Mori Gate.
(5) Delhi Gate.
(6) Rajghat.
(7) Hardinge Bridge.
(8) Princess Park.
(9) Purana Kila.
(10) Barapulla Nalla.

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It is estimated by the Corporation Engineer that about 30 million gallons of crude sewage finds its way into the Jamuna daily as result of these over flows. The effect of the overflow of crude sewage into the river can be disastrous.

3.9 In order to relieve the over-loading of the trunk sewers and to avoid these overflows, the Delhi Municipal Corporation has already taken up a scheme for laying an additional trunk sewer from the Delhi Gate to the Ring Road. A new pumping station is under construction by the Ring Road, which will pick up the sewage from the new sewer and transmit it through a rising main into a high-level gravity duct running to Okhla. The high-level gravity duct has been completed and the sewer from the Delhi Gate to the Ring Road, the pumping station on the Ring Road and the rising main from the pumping station to the high-level duct are reported to be under construction. These works are expected to be completed in about 15 months' time.

3.10 The Committee was informed that this scheme would not be complete without cross-connections between the old and new sewers and without a duplicate rising main from the Ring Road Pumping Station to the high-level duct. It is also reported that the new trunk sewer will have to be extended from the Delhi Gate to the Red Fort as the existing trunk sewers in this reach are also over-loaded. The Corporation has estimated these works to cost Rs. 42 lacs.

3.11 The Old Delhi City area, as already mentioned, is served by a combined system whereby stormwater also finds its way into the sewera, thus overloading these sewers. In order to remedy this, the ideal would be to effect complete separation of stormwater and sewage by providing an independent stormwater drainage system. It is reported that, due to the high congestion of buildings and narrowness of lanes, it will be extremely difficult to lay a completely new stormwater drainage system. The best that could be done is to intercept the stormwater at a few selected points before it enters the sewers and lead it to the Jamuna by new stormwater drains wherever these can be laid. The cost of effecting such partial separation is reported to be Rs. 30 lacs. This amount has already been included in the project estimates for improvement of stormwater drainage.

3.12 The colonies, which are not so far provided with complete sewerage arrangements in this zone, are the private colonies of Hauz Khas,Green Park, Friends' Colony, New Delhi, South Extension, Kailash, Greater Kailash and the Rehabilitation colonies of Lajpat Nagar, Malvia Nagar and Kalkaji. The Civil Lines area and Kotla Mubarakpur also do not have sewerage facilities. As regards the private colonies, internal sewers have already been laid, except in the case of the Friends' Colony. Regarding the Rehabilitation colonies, Lajpat Nagar is partly unsewered but necessary internal sewers in the unsewered areas are being provided. These will be connected to the existing outfall sewer nearby. In the case of Malvia Nagar, the internal sewers are being laid but there is no outfall sewer. Internal sewers are being laid in Kalkaji and the Ministry of Rehabilitation have already sanctioned estimates for laying the necessary outfall sewer for this colony. In the case of the Civil Lines and Kotla Mubarakpur, there are no internal sewers, though the necessary outfalls exist. The works, which will have to be executed to provide sewerage for all these outlying colonies, but which have no financial sanction, therefore, consist of the laying of outfall sewers for the Friends' Colony and Malavia Nagar and the provision of internal sewers in the Civil Lines area and Kotla Mubarakpur. The cost of these works is reported to be Rs. 19 lacs.

3.13 The provision of the additional trunk sewer, mentioned in paragraph 2.9, will ensure that the entire sewage reaches the Okhla treatment plant and no crude sewage finds its way into the Jamuna. The sewage flow from the unsewered colonies, which are now proposed to be sewered, will also go to the Okhla treatment plant. These, in turn, will necessitate increasing the capacity of the Okhla treatment works. The treatment plant at Okhla has, at present, a capacity of 36 m.g.d. out of which 12 m.g.d. is for partial treatment and 24 m.g.d. for complete treatment. The total flow of sewage reaching Okhla, when the new trunk sewer is completed, has been estimated at 66 m.g.d.

3.14 The Delhi Municipal Corporation has already taken up additional works for primary treatment of 30 m.g.d. of sewage. The scheme will not, however, be complete without additional units for secondary treatment with a capacity of 30 m.g.d. The cost of these additional treatment units will be Rs. 60 lacs. It is also reported that the existing arrangements for partial treatment of 12 m.g.d. can be continued as it is anticipated that the effluent from partial treatment can be sold for irrigation. For this, however, it is necessary to extend the irrigation channels at a cost of Rs. 3 lacs.

3.15 The existing activated sludge plant at Okhla was installed in 1936 and it is reported that the machinery is due for renewal. The Committee was informed that the cost of renewal and replacement of this machinery would be about Rs. 15 lacs.

3.16 Till recently, the crude sludge from the treatment plant at Okhla was being digested in open tanks, known as lagoons. This gave rise to considerable fly nuisance as also bad smell in the surrounding areas. The valuable methane gas produced was also being lost. The Corporation has now set up sludge digestion tanks and the sludge is now digested in these tanks, instead of in open lagoons. The gases are collected in gasholders and utilised for the production of electric energy which is used to run the plants. It is reported that, in order to complete this scheme, additional works for gas utilisation are necessary and that these are estimated to cost Rs. 10 lacs.

The Committee was informed that a portion of the effluent from the Okhla treatment plant was being discharged into the Agra Canal. As this increased the manurial property of the irrigation water, the U.P. authorities had no objection to this arrangement. The Committee, however, recommends that a proper standard of purification of the effluent should be maintained so that the water is not harmful to the cattle or people who may happen to use it for domestic purposes.

3.17 It was also brought to the notice of the Committee that, at present, there were 12 subsidiary pumping stations in the South-East Zone to serve areas which could not be drained by gravity into the existing sewers. These pumping stations involve a heavy recurring expenditure. Many of these pumping stations can be eliminated by cross-connection with the new trunk sewer which is sufficiently deep. The cost of such cross-connection is reported to be Rs. 10 lacs.

3.18 In order to ensure satisfactory disposal of sewage in the South-East Zone, the Committee recommends that the following works should be executed, over and above the works which have already been taken up and which have received financial sanction :—

(1)	Laying of relief sewers to relieve the overloaded main drains of New Delhi area . . . . (Paragraph 3·7)	Rs.	7	lacs.
(2)	Extension of the new trunk sewer from the Delhi Gate to the Red Fort, and laying of duplicate rising main from the Ring Road Pumping Station to the high-level gravity duct, cross-connections between the old and new sewers . . . . (Paragraph 3·10)	Rs.	42	lacs.
(3)	Providing outfall sewers for Malvia Nagar and the Friends' Colony and internal sewers in Civil Lines & Kotla Mubarakpur . . . . (Paragraph 3·12)	Rs.	19	lacs.
(4)	Additional secondary treatment plant at Okhla for 30 m.g.d., extension of irrigation channels and renewal of the machinery of the activated sludge plant . . . . . (Paragraph 3·14, 3·15)	Rs.	78	lacs.
(5)	Gas utilisation works at Okhla . . . . . . (Paragraph 3·16)	Rs.	10	lacs.
(6)	Cross connections with the new sewers to eliminate some of the subsidiary pumping stations . . . . . (Paragraph 3·17)	Rs.	10	lacs.
		Rs.	166	lacs.

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NORTH ZONE

3.19 The North Zone comprises an area of 14,000 acres with a Central Valley Line along the Najafgarh Drain. Karolbagh, Rajinder Nagar, Subzimandi, the University area, etc., fall in this zone. The areas on the right of the Valley line are mostly sewered, except for a small area of 300 acres abutting the Mall Road. These areas are served by 3 pumping stations located at Andha Mughal, Subzimandi and the University Enclave. These pumping stations transmit the sewage across the ridge into the trunk sewers of the South-East Zone. The areas on the left are the Model Town, Rana Pratap Bagh, the Radio Colony and the Rehabilitation colonies of Outram Lines, Hudson Camp, Reid's Barracks, Vijaya Nagar, Gur Mandi, Bharat Nagar, Indra Nagar and Azad Nagar. These colonies, excepting the Model Town, Rana Pratap Bagh and the Radio Colony, are unsewered.

The colonies of Rana Pratap Bagh and Radio Colony have septic tank arrangements. The sewage from the other colonies is allowed to enter the Najafgarh Drain. To serve the needs of this entire Zone, a new pumping station and new treatment plant have been set up in 1957, the former near the end of the Najafgarh Drain and the latter near the Coronation Pillar. The pumping station picks up the sewage from the Najafgarh Nalla and transmits it to the Coronation Plant for treatment. Along with sewage, it also pumps a considerable quantity of stormwater.

3.20 The Coronation treatment plant has been set up with the intention of treating the entire sewage of this zone at this plant. The total sewage flow is estimated at 20 m.g.d. The plant has, at present, a capacity of 10 m.g.d. for complete treatment and a capacity of 10 m.g.d. for partial treatment. The effluent from partial treatment, after being used for irrigation, is discharged near the water-intakes at Wazirabad. It is reported that the treatment works will not be complete without the addition of a secondary treatment plant with a capacity of 10 m.g.d. In addition, gas utilisation works will also be installed in order to utilise the gas products of sludge digestion. The cost of these works is reported to be Rs. 36 lacs.

The Committee was informed that the effluent from these plants is to be used for irrigation over areas in the neighbourhood of the Wazirabad Pumping Station. Also, most of the effluent will be discharged into the Najafgarh Drain during periods when water is not required for irrigation. Whether this effluent will be completely free from virus is not clear. The Committee trusts that this matter will receive due attention of the Corporation authorities.

3.21 The main sewer for this zone is already under construction and is expected to be completed within the next 12 months. It starts from the Delhi-Ambala Railway Line, follows the alignment of the Najafgarh Drain, and ends at the north side pumping station. The Committee was informed that the present alignment of the sewer would interfere with the proposed widening of the Najafgarh Drain. Widening of the Najafgarh Drain is considered necessary to improve the drainage in the rural areas. The Corporation should finalise the alignment of this sewer in consultation with the C.W. & P.C. This sewer can serve only the areas on the east of the Delhi-Ambala Railway track. In order to enable it to take the sewage of areas on the west of the railway track, *viz.* Baratpur, Sarai Rohilla, etc., it will have to be extended from the railway track to the old Rohtak Road. The cost of this extension is reported to be Rs. 10 lacs.

3.22 In order to connect the new trunk sewer to the various colonies, a number of branch and main sewers will have to be laid. Internal sewers will also have to be laid in the unsewered colonies mentioned in paragraph 3·19. It is reported that, in the case of the Outram Lines, Hudson Camp and Reid's Barracks, the present haphazard construction does not permit of internal sewers being laid and that there are proposals for dismantling these barracks and reconstructing the area. The question of internal sewers in these areas need not, therefore, be considered for the present and can be taken care of as part of development during reconstruction. Indra Nagar and Azad Nagar are in low-lying pockets and the possibility of providing sewerage in these colonies is remote. As regards Vijay Nagar, it is reported that the estimates for internal sewers are already under the consideration of the Ministry of Rehabilitation and, in the case of Gur Mandi, necessary funds have already been provided. Funds have, therefore, to be found only for laying branch sewers to connect the colonies to the trunk sewers. The probable cost of this is reported to Rs. 35 lacs. This also includes the cost of connecting the areas, presently served by the pumping stations at Andhamughal, Subzi Mandi and the University Enclave, to the new trunk sewer. These pumping stations will be rendered superfluous after these connections are made.

3.23 Summing up, therefore, the further works to be executed to provide sewerage with complete treatment in the North Zone are as follows :—

(1) Gas utilization works and additional secondary treatment units of 10 m.g.d., at the north side treatment plant . (Paragraph 3·20)	Rs. 36 lacs.
(2) Extension of sewer from the Delhi-Ambala Railway line upto the old Rohtak Road . . . . . . (Paragraph 3·21)	Rs. 10 lacs.
(3) Branch sewers draining into the main sewers . . (Paragraph 3·22)	Rs. 35 lacs.
	Rs. 81 lacs.

WEST ZONE

3.24 This zone comprises an area of 19,000 acres with a hilly terrain traversed by the Najafgarh Drain. The Cantonment, Patel Nagar, Rajouri Gardens, Tilak Nagar, etc., fall in this zone. The land on both sides of the drain slopes towards it. A number of colonies have sprung up recently along the Najafgarh Road. A large number of industries with colonies for the workers, have also recently been established. Quite a few Rehabilitation colonies have also been completed by the Ministry of Rehabilitation in this area.

3.25 The colonies in the zone, excepting the Cantonment area, have no integrated sewerage system. Patel Nagar, the National Physical Laboratory, the Pusa Institute, the Central Tractor Organisation and Rajouri Gardens have internal sewers with septic tank arrangements. All the other colonies have the dry system. Besides, a number of new colonies are fast coming up. A dairy, sponsored by the Union Government under the Central Milk Supply Scheme, is also being set up in this zone. It is, therefore, necessary to establish a properly co-ordinated sewerage system for this zone.

3.26 A new sewage treatment plant with a capacity of 12 m.g.d. has been set up by the Delhi Municipal Corporation at Tilak Nagar. The plant is designed to deal with both domestic and industrial wastes to 95% purity. It is intended to use the effluent for irrigation as about 2,000 acres of irrigable land is available near the treatment plant. It is, however, reported that the treatment works will not be complete without the laying of irrigation channels estimated to cost Rs. 3 lacs.

Regarding the effluent, the Committee would draw the attention of the Corporation authorities to its earlier observations made in paragraph 3·20 above.

3.27 In order to connect the various colonies to the treatment plant, a new trunk sewer is being laid along the Najafgarh Road. This is also being connected with Patel Nagar by a trunk sewer along Road No. 34. These trunk sewers will serve parts of the colonies along the Najafgarh Road, Patel Nagar and also the new Milk Colony under construction. They will not be able to serve the areas of the Cantonment, the southern parts of Tilak Nagar, Rajouri Gardens, Ramesh Nagar, the northern half of Moti Nagar, Shivaji Park, and the Co-operative Society's scheme. It is reported that two additional trunk sewers will be necessary, one along the Najafgarh Drain and the other to the south of the Najafgarh Road, parallel to the railway track, to serve these areas and that the cost of these 2 trunk sewers is reported to be Rs. 32 lacs and Rs. 23 lacs respectively. The cost of connecting the internal sewerage system to the trunk sewers through main sewers has been estimated at Rs. 30 lacs.

3.28 The Ministry of Rehabilitation is already taking action for laying the necessary internal sewers in the Rehabilitation colonies, namely, Moti Nagar, Tilak Nagar and Tihar. As regards the private colonies, which do not have internal sewers, the responsibility for laying these sewers to connect them with the branch sewers will be that of the colonisers themselves.

3.29 The Committee, therefore, recommends that the following further works should be taken up and completed, in order to provide the West Zone with an integrated sewerage system :—

(1) Irrigation channels at the Tilak Nagar plant . . (Paragraph 3·26)	Rs. 3 lacs.
(2) Laying trunk sewer along the Najafgarh Drain . . (Paragraph 3·27)	Rs. 32 lacs.
(3) Laying trunk sewer south of the Najafgarh Rood parallel to railway line . . . . (Paragraph 3·27)	Rs. 23 lacs.
(4) Laying branch sewers . . . . . . (Paragraph 3·27)	Rs. 30 lacs.
	Rs. 88 lacs.

SHAHDARA AREA

3.30 The Shahdara Area, comprising an area of about 3,500 acres, consists of the colonies of Shahdara North & South, Gandhi Nagar, Geeta Colony and Krishna Nagar. The whole area is, at present, served by the dry system and the sullage flows through open drains into soak pits or low-lying pockets. Crude night-soil is dumped in open areas, giving rise to insanitary conditions.

3.31 The entire area is low-lying and remains water-logged for the greater part of the year. Proposals have been made for the proper drainage of this area but it will be long before a proper underground sewerage system can be laid.

3.32 As an immediate solution to the problem of insanitary conditions prevailing at present, the Delhi Municipal Corporation has proposed that two night-soil digestion tanks may be set up. Their location and layouts will be so arranged as to fit in with the future purification works and underground sewerage system as and when the same could be laid. The Committee accepts these proposals and recommends their immediate implementation. The cost of the two night-soil digestion tanks is reported to be Rs. 7·6 lacs.

3.33 It has been pointed out to the Committee that, due to the low cost of the land, its vicinity to the city, and comparatively cheap transport, the pace of development in the Shahdara area is bound to quicken in the near future. It is, therefore, necessary to plan ahead for providing an underground sewerage system with purification plants for this area. In the absence of detailed investigations, only a very rough idea of the cost of providing these amenities can be formed at present. The probable cost has been worked out by the Delhi Corporation at Rs. 1·39 crores, as detailed below :—

(1) Internal sewers for 3,500 acres @10 annas per square yard	Rs. 1,06,00,000/-.
(2) Main sewers	Rs. 16,00,000/-.
(3) Pumping stations 3 Nos. and rising main . . .	Rs. 7,00,000/-.
(4) Purification plant -6 m.g.d. primary treatment and sludge digestion	Rs. 10,00,000/-.
	Rs. 1,39,00,000/-.

At present, Shahdara has no piped water supply. The question of provision of water-borne sewerage system will not arise till piped water supply is arranged. The Committee, therefore, feels that this could wait till Shahdara is provided with piped water supply.

3.34 Summing up, the improvements suggested are :—

(1) Providing sewerage to colonies which are unsewered at present.

(2) Providing relief sewers both for main and branch sewers wherever there is evidence of overloading.

(3) Elimination of overflow of crude sewage into the river.

(4) Increasing the capacity of the existing treatment plants.

(5) Separation of sewerage from the stormwater drains where a combined system exists.

The total cost of all the improvements suggested above comes to Rs. 4.82 crores. While it is desirable to carry out immediately all the improvements suggested, the completion of all these schemes will take time. Therefore, the work required to be done has been subdivided into works of an urgent nature, which should be taken up for execution as soon as the final investigations are completed, and the remaining, which could be taken up later. The details of the works and costs phase-wise will be found at Appendix VIII.

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SECTION 4

THE PROBLEM OF SUB-SOIL WATER

4.1 An Ad Hoc Committee for investigating the condition of the sub-soil water table in New Delhi was appointed by the Government of India in September, 1953. The terms of reference were "to examine the question whether the sub-soil water table in New Delhi area is rising and, if so, to suggest what, if any, protective measures are necessary to safeguard the buildings in New Delhi".

4.2 The problem posed was of a complicated nature and all that the Ad Hoc Committee could do during the first two months of its existence was to suggest the lines on which further investigations were to be carried out. This was conveyed to the Government in its first interim report submitted in January, 1954. This was followed by a second interim report in November, 1958.

4.3 The original terms of reference did not cover all the problems relating to the rise of sub-soil water and the final issues, that emerged as a result of investigations of the committee, are :—

(i) To what extent has the water table risen and whether it is still rising or has attained a state of equilibrium ?

(ii) What are the causes of the rise of sub-soil water table?

(iii) Has the rising water table caused any damage to buildings, crop or trees and is it likely to cause any further damage by way of :—

  (a) Reduction in the load-bearing capacity of the soil on which foundations of buildings rest;

  (b) Rise of salts and development of alkalinity in upper layers of the soil, thereby making the soil unfit for gardening and lawns ;

  (c) Water-logging of soil, giving rise to insanitary conditions ?

(iv) Is the sub-soil water suitable for irrigation ?

(v) To what ultimate level the water table should be lowered and stabilised ?

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4.4 The Ad Hoc Committee has had 21 meetings so far. A summary of its report (under submission) is given below :—

PHYSICAL FEATURES ; SOIL PROFILES AND SUB-SOIL WATER

4.5 It was observed that the New Delhi area, before its development, was good agricultural land with adequate slopes. According to the original townplanners of New Delhi, the sub-soil water table was not expected to give any cause for anxiety. The physical features changed in the process of urbanisation. Original drainage channels were filled up and underground stormwater drains provided to suit the layout of roads and location of buildings.

4.6 The soil of New Delhi can be classified as sandy silt or silty sand with no plasticity. A characteristic of the soil of the semi-arid zone, under which New Delhi falls, is the presence of excessive quantity of salts in them. Examination of the soil profile in the Central Vista indicates accumulation of salt at soil surface due to the rise of sub-soil water. The soil has very low permeability and does not yield water; nor does it allow underground water to flow easily.

4.7 Extensive chemical tests on well water in the New Delhi region were carried out. Except for a few isolated wells, underground water of Delhi area is generally saline and unfit for drinking or irrigation.

STUDIES OF FLUCTUATIONS OF WATER TABLE

4.8 The levels of water in the open surface wells in the area observed in 1912 were the earliest record of sub-soil water table available to the Ad Hoc Committee. At its instance, a grid of 91 observation pipes were sunk in 1954. Fortnightly observations reveal that there has been a steady rise of the water table since 1912 and that the rise varies from 2·5′ to 15·11′ in different parts of New Delhi. On the basis of the observed water table, which is the highest in the month of October, the New Delhi area can be divided into 3 zones :—

ZONE I	The area where the sub-soil water table in October is within 6′ from the ground surface. This is termed as "Badly Affected" area. This is the area where the maximum damage to buildings, roads and vegetation can take place as a result of water logging.
ZONE II	This zone, termed as "Moderately Affected" area, covers the area where the water table is 6′ to 10′ from the ground surface.
ZONE III	Area where the water table in the month of October is at a depth greater than 10′ from the ground surface.

4.9 From the Iso-hydrographs drawn every year, it is observed that more and more areas under Zone III are passing into Zone II and, similarly, areas from Zone II are passing into Zone I. The statement given below indicates the alarming rate at which large areas of land, which were safe have passed on to what are termed as "moderately" and "badly" affected areas :

Serial No.	Depth of water table from ground in October	Area in acres in Oct. '54	Area in acres in Oct. '55	Area in acres in Oct. '56	Area in acres in Oct. '57	Area in acres in Oct. '58
1.	Within 6 ft. .	256	545	920	1,040	3,200
2.	From 6′ to 10′ .	3,114	3,415	3,470	3,930	6,000
3.	More than 10′ .	6,430	5,840	5,410	4,830	600

Apart from this, the other conclusions drawn are :—

1. The sub-soil water table rises from June to October.
2. It falls from October to June but there is generally a net rise from June to June.
3. Heavy rainfalls during the monsoon are responsible for the abnormal rise during that period.
4. Since 1912, there has been a general rise in the sub-soil water table, varying from 1·67 feet to 15·87 feet.
5. Net annual rise of sub-soil water is the least in the case of badly affected areas and is the maximum in the case of Zone III.
6. Whether a state of equilibrium has been attained in the badly affected areas is difficult to say. A final conclusion on this point can be arrived at after the results of observations over a long period of time are available.

CAUSES

4.10 The rise in the sub-soil water is due to addition to the underground water table by way of percolation or seepage. The sources of percolation or seepage could be—

1. The River Jamuna.
2. Holding up of stormwater due to urbanisation.
3. Irrigation.

4.11 The view that the river Jamuna could be the cause of the high water table in the New Delhi area has not been borne out by the observations. The sub-soil water level is higher than the general river level and, therefore, the river has no influence on the sub-soil water level beyond about 1000 on either side.

4.12 The major factor contributing to the rise in the sub-soil water table is that a part of the stormwater, which is caught up in the compounds and berms of roads, cannot find its way into drains and finally percolates into the sub-soil. Rise in the water table due to this cause is related to rainfall. The greater the rainfall during the monsoon, the greater the rise in the water table. The observations recorded below bring out the effect of the rainfall on the sub-soil water level. They relate to a point near the Factory Road.

WATER LEVEL AT BORE 88, A POINT NEAR FACTORY ROAD

Year	Rainfall in monsoon	Duration of monsoon	Level of sub-soil water in June	Effective rise from June to June	Level of sub-soil water in Oct.	Rise during the period of monsoon
1955	27·74″	15th June to 15th Oct.	686·70		691·29	4·59′
1956	31·24″	Do.	689·03	2·33′	693·70	4·67′
1957	24·65″	1st June to 15th Sept.	691·20	2·17′	695·55	4·35′
1958	38·34″	1st July to 30th Sept.	691·70	0·50′	699·00	7·30′

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4.13 During urbanisation, the existing drainage lines, such as nallas and ravines, are disturbed to suit the layout of roads and buildings. The slope of the ground is altered. The percentage of impervious area is considerably increased, which should result in greater run-off, but, if it is held back, the effect is reversed. The drainage system should be able to dispose of quickly the run-off generated by rainfalls of normal intensities. If the system is not capable of doing so, the stormwater stagnates and, finally, most of it seeps into the ground to add the ground water table. Compound walls, constructed to demarcate boundaries between bungalows in New Delhi, also block free flow of water. Also, originally, the lawns were made saucer-shaped to conserve rain and irrigation water. These depressions have reduced the run-off and increased the seepage. All these factors contribute to the rise of sub-soil water and indicate the need for an efficient drainage system.

4.14 Irrigation also contributes to seepage of water into the ground. In the New Delhi area, the total quantity of water utilised for irrigation amounts to a delta of 45″ in the irrigated area. Apart from this high delta of 45″, there is also evidence of faulty and wasteful irrigation practices.

HARMFUL EFFECTS OF SUB-SOIL WATER

4.15 A high water table can be harmful to buildings, metalled roads and vegetation. In the case of buildings, foundations are likely to settle and the dampness may rise above the plinth level, making houses unfit for living. Sodium sulphate, coming up with the rising water table, causes efflorescence on the surface of bricks bringing about their disintegration. Most of the buildings in New Delhi are not provided with a damp-proof course. A large number of such building have been affected by dampness .

4.16 On metalled roads, even the minutest crack permits the upward movement of moisture and sudium sulphate contained in the sub-soil water. During the winter, sodium sulphate crystallises, developing a considerable amount of disintegrating force which ruptures portions of roads. So far, no roads have been reported to have been seriously affected in this way.

4.17 When the rising sub-soil water table comes within the root zone of crops, the air present in the soil is driven out and the vegetation is deprived of oxygen necessary for its growth . Such conditions make the growth of vegetation stunted and, ultimately, cause its death. Long before actual water-logging takes place, the sodium salts present in the soil profile and those coming up with the rising water table begin to react on the soil and convert it into a saline alkaline soil which is infertile. Portions of the Central Vista have been affected by salts due to the fluctuations of sub-soil water.

4.18 To eliminate these harmful effects, it is essential that the rise of the water table should be arrested and, wherever it is high, it should be lowered to a safe depth.

DEPTH TO WHICH THE WATER TABLE SHOULD BE LOWERED AND EFFECTS OF LOWERING THE WATER TABLE TO THAT DEPTH

4.19 The point to be decided is the safe depth to which the water table is to be lowered, stabilised and maintained. The *Ad Hoc* Committee has come to the conclusion that, if the water table is kept at a depth of 10 feet or more from the ground surface, it is not likely to contribute any salts to the ground surface. The roots of the majority of vegetation and trees remain within the first 10 feet of soil and would, therefore, not suffer from the presence of free water below this level.

4.20 Most of the buildings in the New Delhi area have their foundations at depths of 4′ to 6′ below the ground level. Allowing for capillarity, if the water level is maintained at 10′ below the ground level, it is not likely to have an adverse effect on the buildings. Therefore, the *Ad Hoc* Committee recommends establishing the water level 10′ below the ground level in the month of October. The average monsoon rise being of the order of 3′ to 4′, the water table must be lowered to 13′ to 14′ before the advent of monsoon.

4.21 The *Ad Hoc* Committee apprehended that the sudden lowering of the water table might be dangerous to structures as it might cause subsidence and differential settlement. The Central Road Research Institute was, therefore, requested to study the effect of lowering the water table on foundations of existing buildings. They have reported that the possibility of any appreciable surface subsidence occurring in the region investigated, as a result of lowering the water table to a depth of 13′ to 14′, is remote. The differential settlement is also not likely to be of a high magnitude.

4.22 *Remedial Measures*—The main recommendations of the *Ad Hoc* Committee could be broadly divided into :—

(1) Measures necessary to prevent the rise of sub-soil water by improving the drainage and economising in the use of unfiltered water.

(2) Measures necessary to lower the sub-soil water, wherever it is high, by tube-wells and porous pipes.

(3) Measures for soil reclamation.

4.23 *Drainage* :—The original intention of the town-planners was to provide a run-off of ½″ for the area as a whole and 1″ for special areas. In actual construction, a run-off of ¼″ was provided against that of ½″. The

Ad Hoc Committee has not been able to trace the recorded reasons for this major change. It could not possibly have been done without adequate considerations, especially when the designers took meticulous care in working out the sizes of all the drains from the samllest to the largest. The *Ad Hoc* Committee has examined the existing drainage system. It consists of four independent systems having their out-fall channels joining the river. The main drainage system has a designed capacity of 1,066 cusecs at the cemetery chamber. Below this point, the stormwater is carried by an elliptical conduit, the capacity of which is, however, only 563 cusecs. This channel discharges into a trapezoidal conduit which has a capacity of 933 cusecs. Ultimately, the system joins the open Barapulla Nalla which again has a bottleneck at the Mathura Road Bridge, which gives an afflux of 3 ft.

4.24 If the drainage system is redesigned for a run-off of ½″ per hour, it would be adequate for a storm of intensity of 1·65″ per hour likely to occur once in two years. This will mean doubling the capacity of the existing drainage system. The *Ad Hoc* Committee feels that, as a first step, the bottlenecks mentioned above and hereafter should be removed and the performance of the drainage system carefully watched by discharge observations at various points to determine the actual run-off and to correlate it to rainfall and flooding. On the basis of these actual observations, further improvement to the drainage system could be taken up.

4.25 The bottlenecks of the elliptical conduit as well as of the Mathura Road Bridge must be immediately removed. The discharge sites must be carefully determined and observations taken during the monsoon period with a view to determining the correct run-off.

4.26 Another imperative measure is the improvement of the outlets under the pavements. At present, these consist of 4″ pipes which get choked by debris. The size should be increased with the bell-mouth on the external side and the pipes should be laid obliquely to the road.

4.27 Other measures, suggested for quick removal of stormwater, are:—

(*a*) Improving the drainage of lawns and gardens.

(*b*) Providing underground stormwater drains in open areas, like the Central Vista and other gardens, where such drains do not exist.

(*c*) Ensuring effective drainage of bungalow compounds.

(*d*) Improving the interception arrangements.

Economic use of Unfiltered Water

4.28 The evidence placed before the *Ad Hoc* Committee has led it to believe that the system of irrigation in vogue leads to excessive use of water. Economy in the use of unfiltered water could be effected by cutting off water supply on rainy days and at night during the months of August, September, December and January. Apart from such administrative measures, the suggestion is that, wherever possible, the sprinkler system of irrigation should be adopted.

Physical Removal of Sub-soil Water

4.29 The *Ad Hoc* Committee lays great emphasis on the provision of tubewells to lower the water table in the badly and moderately affected areas where the water table is either near the ground surface or approaching it. 15 tubewells are already working in the badly affected areas and it is now proposed to extend the tubewell scheme to the remaining areas affected by the sub-soil water table, by sinking 287 additional tubewells. This will be on the basis of 1 tubewell per 32 acres.

4.30 It is expected that, if the improvements to the drainage, as suggested above, are carried out, there will be abatement in the rate of rise of sub-soil water. But this cannot altogether eliminate a net yearly addition to the water table due to low permeability of the soil which does not allow underground water to flow easily. As already stated, more and more areas are drifting into what are termed as badly affected areas. This rate is alarming. The

Ad Hoc Committee's advice, therefore, is that no further time should be lost in providing the proposed additional tubewells to lower the water table in the New Delhi area. The working of these tubewells should be regulated to pump the requisite quantities of water from the sub-soil.

4.31 The *Ad Hoc* Committee has also examined the possibility of utilising this sub-soil water from tubewells for irrigation or drinking. Water containing salts more than 60 parts per 100,000 parts of water is not suitable for irrigation. Water from tubewells in the New Delhi areas is generally saline and does not satisfy the above requirements. It is, therefore, unsuitable for irrigation. Apart from salinity, the water of shallow tubewells is liable to contamination and is, therefore, unsuitable for drinking purposes. In discharging this water into the river through the drainage system, no difficulty is anticipated. If, however, due to continuous pumping, the quality of water improves,.it could be utilised for irrigation.

4.32 Another recommendation of equal importance is the laying of porous drains in open areas and also in areas to be developed. This arrangement will supplement the underground drainage. Water collected with porous pipes can be drained by gravity if levels permit ; otherwise, it will have to be disposed of by pumping. A gallery of porous pipes laid in the Central Vista has given satisfactory results. A scheme of such porous drains has also been prepared for the 129-acre colony south of the Hindustan Housing Factory. The *Ad Hoc* Committees recommendation is that, before development, a network of porous drains should be laid underground in all new areas taken up for urbanisation. It has been brought out in this report that drainage by porous drains in new areas would, in the long run, be cheaper and less troublesome than lowering the sub-soil water by tubewells. It is also recommended that standing instructions should be issued that, while surveying new areas for development, examination of the soil profile should be made to decide the capacity of underground drainage required.

SOIL RECLAMATION

4.33 An experiment to reclaim saline and alkaline land in the Central Vista by leaching and use of D.D.T. waste gave encouraging results. It was, however, a partial success, largely on account of the fact that the water table was high and there were no sub-surface drains to take away the salts removed by leaching. Further trials with leaching, using D.D.T. waste and gypsum, have been suggested. These should be carried out after porous underground drains are provided.

FURTHER WORK TO BE CARRIED OUT

4.34 In its deliberations, the *Ad Hoc* Committee has been handicapped for want of adequate data and full statistics for a correct appreciation of the behaviour of the sub-soil water table. For such a study, data over a number of years is necessary. The *Ad Hoc* Committee would, therefore, recommend the continuance of studies so far carried out and also further studies as enumerated below :—

(1) Observation pipes should be extended to colonies recently developed and to areas likely to be built upon in the near future. The study of fluctuation of the water table on the basis of those observations should be continued, as is being done at present.

(2) A careful record of the amount of unfiltered water used for irrigation should be maintained.

(3) A record of discharge of various nallas during the rains should be kept. The working of the drains during the monsoon should be observed. In addition, the quantity of water pumped from tubewells should be compared with the quantities at the outfall points to make sure the losses in transit are the minimum.

(4) Chemical examination of water should be carried out from time to time and, if the quality of water improves with pumping, it should be utilised for irrigation.

(5) Reclamation of the Central Vista should contiune. The I.A.R.I. should be requested to investigate and report on the optimum delta for lawns for the conditions obtaining in New Delhi.

(6) The Geological Survey of India should investigate the geo-hydrological conditions of the New Delhi region.

4.35 For this, the *Ad Hoc* Committee recommends the setting up of a separate Cell under the Chief Engineer, Central P.W.D., to collect and record all the data on the rise of the water table, rainfall, amount of water pumped from sub-soil, amount of water removed from drains, etc. This cell should remain in touch with investigations carried out by the Institutes and prepare quarterly, half-yearly and yearly reports on the basis of the data collected from time to time.

TOTAL COSTS

4.36 The total cost of schemes for lowering of the sub-soil water table has been worked out at Rs. 30 lakhs. This does not include the cost of improvements to drainage, which has been separately dealt with in Section 2. This, however, does not provide for the recurring expenditure on the running of tubewells.

4.37 This Committee accepts the findings and recommendations of the *Ad Hoc* Committee on Sub-soil Water and recommends speedy implementation of the various remedial measures suggested therein. The implementation of these recommendations will be the responsibility of the Ministry of Works, Housing and Supply.

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SECTION 5

FLOOD PROTECTION WORKS

5 1 Parts of Delhi have often been subjected to flooding when the river Jamuna is in spate. The Committee was informed that flooding of parts of the Delhi State is due to inadequate capacity of the river in this reach to carry the full flood discharge and also to the flat nature of the region. The flooding is generally confined to the rural areas between the river and the Shahdara Bund on the left bank, and between the river and the Delhi-Karnal G.T. Road on the right bank.

5.2 The floods of 1924 caused heavy damage to the Tajewala Headworks. Shahdara in the Delhi State was under 4 ft. to 5 ft. of water. The Delhi-Shahdara railway line was damaged in portions and was closed to traffic for a period of one month. After this, there were not many high floods till 1947. Again in 1955, the river rose to a level of 675·5 at the Railway Bridge, flooding many low-lying areas in the Delhi State. Shahdara was again badly affected and there was considerable dislocation of traffic.

5.3 After the floods of 1955, the Shahdara Bund was constructed in order to protect areas on the left bank of the Jamuna. However, in 1956, the flood level at the Jamuna Bridge rose to 677·3, the highest level recorded so far. Although the Shahdara area was saved by the new bund, timely efforts were necessary to prevent breaching at the junction of the bund with the Railway Bridge abutment. The left marginal bund from the Jamuna Bridge to the Okhla Weir had to be provided with a sand bag dowel to save it, as water had almost reached the level of the top of the bund.

5.4 For the purpose of flood protection measures, the Jamuna can be divided into two reaches :—

(*i*) The reach from the Delhi-Punjab border to the Railway Bridge;

(*ii*) The reach between the Railway Bridge and Okhla.

(i) *Delhi-Punjab border to the Railway Bridge.*—In this reach, we have, on the left bank, the Shahdara Bund and, on the right, the bund from the G.T. Road to the Coronation Pillar, the bund from the Coronation Pillar to the Shah Alam Bridge and the National Highway Bund from the Alipur Mall Road to the Jamuna Bridge. (Refer to Plan No. 3 for details of bunds). The floods during the period 1956—58 showed that the section of the bund from the Coronation Pillar to the Shah Alam Bridge was not quite adequate and, therefore, needed strengthening. As a result of the construction of the barrage across the river Jamuna at Wazirabad, the flood level in the Jamuna will rise upstream of the barrage. The section of the bunds will have to be checked with reference to this rise in water level also. Proposals for raising and strengthening the bunds have been finalised by the Central P. W. D. in consultation with the C. W. & P. C.

SHAHDARA BUND

5.5 The Shahdara Bund extends beyond the Wazirabad Barrage. The downstream portion of this bund will not need any modification inasmuch as there will be no rise in the water level downstream of Wazirabad as a result of construction of the barrage. The H. F. L. at the barrage on the upstream is expected to be 685. Allowing a free board of 4 ft., the top level of the bund will have to be 689 against its present level of 683·3. From this point onwards, the bund will have a rise of 1 in 10,000 towards the upstream side. The level of the bund at the upstream end will be 691·65, while the high flood level in this reach will be 687·65. The top width of the bund, after raising, should be 24 ft., and not 15 ft. as proposed. The proposed section of the bund will provide a cover of 3 ft. over the hydraulic gradient. The three existing regulators of the bund will be modified to meet the new flood conditions. It has been estimated that the total cost of these improvements will be about

Rs. 11.60 lakhs. As the modifications to the bund have been necessitated by the construction of the barrage at Wazirabad, which is meant to improve the water supply to Delhi, the entire cost is debitable to the Delhi Municipal Corporation.

The Committee was informed that the top width of the bund had been kept at 15 feet in order to bring down the cost to Rs. 7·60 lakhs. The Committee, however, feels that it would be preferable to maintain a minimum width of 24 feet for the bund. The extra expenditure involved on this account is reported to be Rs. 4 lakhs. The Committee recommends the early completion of this work.

BUND FROM THE SHAH ALAM BRIDGE TO THE CORONATION PILLAR

5.6 This bund needs strengthening even to deal with the existing flood conditions. It will also have to be raised to deal with the increased flood level as a result of the new barrage under construction. The H. F. L. at the Shah Alam Bridge, after the completion of the barrage, is expected to be 685·05 and the top of the bund will have to be 689·05. The bund will have a rise of 1 in 10,000 towards the Coronation Pillar, at which point its top level will be 690·12. The bund from the Coronation Memorial to the G. T. Road will be raised to a uniform level of 690·12 throughout its length.

5.7 The existing regulators and culverts along the two bunds will also require modification. In order to accommodate the increased width of these bunds, the Najafgarh Drain will have to be shifted and re-aligned in a small reach. At the Shah Alam Bridge, a retaining wall will be necessary to prevent the side slope of the bund from encroaching on the waterway.

5.8 The total cost of the improvements to the right bank bunds mentioned in paragraphs 5.6 and 5.7 is estimated to be Rs. 11,44,731/-. Part of this, amounting to Rs. 7,44,000/-, is chargeable to the flood work and the remaining represents the cost of works necessitated as a result of the construction of the barrage. This portion of the expenditure will be the liability of the Corporation. Tenders for this work (earth work portion) have already been invited by the C. P. W. D.

5.9 The newly constructed National Highway from the Alipur Mall Road upto the Jamuna Bridge serves as a flood protection bund in this reach. It has 3 culverts all of which are provided with regulators. This National Highway bund is adequate to withstand the floods and needs no improvements.

5.10 There are a few villages situated between the Grand Trunk Road and the river bank. These are subject to constant threat from floods in the Jamuna. The possibility of constructing an embankment connecting the Coronation Memorial Pillar to the Palla bund was examined by the Jamuna Committee. This Committee came to the conclusion that no new long embankments should be constructed on the Jamuna from Tajewala to Delhi, as these would cut off large valley storages, resulting in higher flood levels at Delhi. In the light of this decision, the above proposal had to be dropped. The alternative solution for the protection of these villages will be either to raise these villages above the H.F.L. or to protect them by ring bunds, or to shift them away from the flood plain. There are twelve such villages, 4 on the right bank and 8 on the left bank. As no other protective measures are possible, it has been decided to shift these twelve villages on the landside of the bund. The Committee was informed that the Delhi Administration had already acquired new sites for the resettlement of the affected villagers. The Committee would recommend the completion of this resettlement work before the next floods.

5.11 The colonies of Indra Nagar and Adarsh Nagar are situated on the G.T. Road to Ambala on the riverside of the bunds. These colonies are surrounded by water when the river is in spate. It has not been possible for the investigating agency to examine the flooding problems of these colonies. The Committee recommends early completion of the investigations and formulation of necessary measures to protect these areas from floods.

5.12 (ii) *Jamuna Bridge to Okhla.*—On the left of the Jamuna below the Railway Bridge, is the left Marginal Bund, which is also known as the Salimpur Bund. It starts from the bridge and goes up to the Okhla Weir. It protects the areas of Gandhi Nagar, Krishna Nagar, Partap Ganj, etc., from the ravages of floods. When the river water level rose to 677·3 under the Railway Bridge during the floods of 1956, the water rose to the top level of the Marginal Bund. This showed the necessity for raising the level of the bund in a stretch of 8 miles keeping its top width to 15 feet and top level 4 feet above the observed high flood level. The cost of this work has been estimated at Rs. 12·28 lakhs and the Committee was informed that sanction for this work had already been accorded by the Government of India and that the work was being executed by the U.P. State P.W.D.

5.13 There is a continuous line of bunds on the right bank of the river downstream of the bridge up to the Nalla No. 12 up to the end of the Indraprastha Estate. These bunds have been recently strengthened and no further improvement is considered necessary. Spurs have been provided on the Moghul Bund to prevent erosion of land near the Power House. Downstream of the Indraprastha Estate, the Ring Road (bypass) serves as a river bund and all the bridges have been provided with regulators upto the Barapulla Nalla. There is no regulating arrangement at this point. Flooding of low-lying areas between the Ring Road and the railway track, as a result of back flow in the nalla when the river is in spate, is common. The Barapulla Nalla has no defined banks in this reach and the floods spread out over the low-lying areas. While suggesting improvements to the drainage of the Barapulla catchment, the C.P.W.D. has suggested provision of regular bunds to the Barapulla Nalla in this reach between the railway track and the Ring Road. The cost of canalising the nalla in this reach is already included in the project estimate for drainage of Block No. I.

MAINTENANCE

5.14 The bunds should be maintained to the standards prescribed by the Central Water & Power Commission in terms of the Embankment Manual prepared by the Flood Wing of the C. W. & P. C. in 1956. The bunds should be carefully inspected in the month of October each year, *i.e.*, soon after the flood season is over. Wherever necessary, action should be taken to carry out effective repairs and take steps to strengthen the bunds if flood levels obtained during the preceding floods call for such action. This work should be completed during the winter months, and a second inspection should again be made in the month of April to ensure that all necessary work has carried out and that the bunds are in a proper condition. A report should be made after this inspection by the Delhi State P. W. D. through the Chief Commissioner, Delhi, to the Ministry of Irrigation and Power and the Ministry of Home Affairs. Similar action should be taken by the Superintending Engineer, Agra Canals (U.P. Irrigation Department) on the marginal bund on the left bank of the Jamuna under his charge.

SECTION 6

EQUIPMENT

6.1 The implementation of the various schemes recommended will go a long way in solving the drainage and sewerage problems. This will, however, take some time, say four or five years ; and, meanwhile, the possibility of flooding of local spots cannot be ruled out. Further, even after all the improvements are effected, there will still be some flooding, when rainfall of intensities higher than 1·65″ per hour occurs. It is, therefore, necessary to have the requisite equipment to deal with such emergencies.

6.2 The agencies responsible for the maintenance of the drainage and sewerage systems are the N.D.M.C. and the Delhi Municipal Corporation. The Committee has observed that neither of these agencies has the necessary equipment to deal with the flooding of low areas. Instances are many when the Defence authorities had to go to the rescue of the local bodies with their equipment. This is unsatisfactory and the Committee considers it essential for the N.D.M.C. and the Corporation to be self-sufficient in the matter of equipment.

6.3 It has been brought to the notice of the Committee that the Delhi Municipal Corporation has now procured two pumps—one of 9 B. H. P. and the other of 12 B. H. P. They have also placed orders for five more pumps of 15 B. H. P. and three of 5 B. H. P. and for five sewer-cleaning machines. The procurement of this machinery will enable the Corporation to deal with the flooding of local spots without outside help.

6.4 The N.D.M.C., on the other hand, has, at present, no equipment to deal with such emergencies. It has now worked out the requirements of equipments for dealing with flood emergencies and these are listed below:—

	Rs.
1. 2 pumps of 500 g.p.m. each	36,000
2. 2 pumps of 200 g.p.m. each	24,000
3. One Jeep for quick transportation of pumps . . .	13,000
4. Accessories	7,000

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The Committee recommends the purchase of this equipment by the N.D.M.C.

6.5 The recommendations now made by the Committee for improvements to the drainage and sewerage arrangements will involve the laying of a number of new drains and sewers as well as large-scale remodelling of nallas. The execution of these works without adequate equipment will be extremely difficult as sewers and drains have to be laid at great depths under high sub-soil water. Nallas, like the Najafgarh Nalla, which is rarely dry, have to be widened and deepened. It is, therefore, necessary to have special equipment for the execution of these works.

6.6 The main agencies for the execution of the works will be the C.P.W.D. and the Delhi Corporation. These agencies were asked to examine the adequacy of the equipment already with them and to report if any further equipment was needed. The C.P.W.D. have asked for two drag line excavators. These will be useful not only for remodelling the Najafgarh Nalla but also for maintenance of the nallas. The Corporation has come forward with a demand for a well point equipment which will be helpful in laying deep sewers and stormwater drains in areas with a high sub-soil water level. The cost of two drag line excavators has been reported to be Rs. 5 lakhs while the cost of the well point equipment will be Rs. 4 lakhs.

6.7 The Committee accepts the necessity for the equipment mentioned above and recommends its early procurement.

SECTION 7

ADMINISTRATIVE AND FINANCIAL ARRANGEMENTS

7.1 The improvements suggested and other recommendations made in this report will involve a total financial outlay of Rs. 10·05 crores which has been arrived at as under :—

		Rs. (lakhs)
(i)	Stormwater drainage	479
(ii)	Sewerage and sewage disposal	482
(iii)	Preventing rise in the sub-soil water level . .	30
(iv)	Flood protection works	4
(v)	Equipment	10
		1,005

These figures are intended to give an indication of costs of the various projects recommended in this report and are likely to undergo variations as a result of detailed investigations.

7.2 It may be observed that the Committee was charged with the responsibility of implementing its recommendations also. While the Committee has been able to ensure action with regard to matters which required immediate attention, *vide* Appendix II, the recommendations made in this report involve comparatively long-term measures. In its present form, the Committee cannot take steps towards the implementation of such measures as it expects that the various local bodies and administrative Ministries, directly concerned with these problems, will deal with them. For instance, the flood protection measures have to be dealt with by the Delhi Administration and also part of the drainage works relating to the rural areas in the Najafgarh catchment is the responsibility of the same Administration, except where certain works may have to be executed by the Punjab Irrigation authorities. Other problems relating to drainage and sewerage will have to be dealt with either by the Corporation or by the New Delhi Municipal Committee. As regards the problem of sub-soil water (other than drainage), the Committee recommends that this should be made the responsibility of the Ministry of Works, Housing and Supply.

7.3 Based on the sphere of responsibility, indicated in the preceding paragraph, a financial break-up has been made with regard to items referred to in paragraph 7.1. It is indicated in the statement attached as Appendix IX. The position is briefly summed up below :—

		Rs. lakhs
(i)	Delhi Corporation	614
(ii)	New Delhi Municipal Committee	202
(iii)	Delhi Administration	154
(iv)	Ministry of W. H. & S.	35
		1,005

As stated above, the Committee would recommend that all these agencies should take urgent steps towards the implementation of the recommendations made in this report. The Committee feels that one of the major difficulties will be the finance required inasmuch as the Corporation and the New Delhi Municipal Committee will not find it easy to earmark and spend, in the immediate future, such large amounts towards the execution of these works. If the Corporation or the N.D.M.C. go up to the Government of India for loan assistance or grants-in-aid, as may be required, the Committee recommends that such necessary loan assistance or grants-in-aid should be made available as early as possible.

7.4 For the implementation of the recommendations, the various agencies, referred to above, will have to strengthen their field engineering organisations. These organizations will be required to carry out necessary investigations and proper detailed projects and execute them. The Committee recommends that early action should be initiated towards that end. The Delhi Administration and the Ministry of Works, Housing and Supply will have little difficulty in this regard inasmuch as they already have the assistance of the Central Water & Power Commission or/and the Central Public Works Department for this purpose. The Corporation will have to suitably strengthen its own engineering organisation so as to undertake and complete these works as early as possible. So far as the New Delhi Municipal Committee is concerned, it has one engineering Division, staff for which has been supplied by the Central P.W.D. on deputation. For investigating and executing the schemes covered by this report, the N.D.M.C. will require the assistance of the Central P.W.D. and this should be made available to them.

7.5 It has been mentioned in Section 1 that, under the direction of the Committee, a special set-up has been created under the Central P.W.D., the Corporation and the Delhi Administration for carrying out preliminary investigations. Till the field organisations, referred to in paragraph 7.4, are in position, the Committee recommends that the present set-up should continue as an interim measure, and carry out further investigations of the works, and, in particular, those included under Phase I. The detailed schemes thus prepared will have to be processed further by the various agencies referred to above and will be taken up for execution by their field engineering organizations. This interim arrangement will ensure continuity and avoid delay in the implementation of the recommendations.

7.6 While the Committee expects that the various agencies referred to above will take adequate steps towards the implementation of its recommendations, it feels that there is need for one authority that should be made responsible for formulating policies and ensuring co-ordination in relation to the problems that have been dealt with in this report. This is necessary because there are multiple organizations handling these problems today. The area of the erstwhile Delhi State now falls within the jurisdiction of the Delhi Corporation, excepting areas controlled by the New Delhi Municipal Committee and the Cantonment Board. A good deal of co-ordination is necessary among them, particularly as between the N.D.M.C. and the Corporation, as their drainage, sewerage and water-supply systems are interlinked and inter-dependent. There are problems which again, are the responsibility of the Delhi Administration. These are connected with the rural drainage and flood protection works and, in these, the co-operation of the Punjab and U.P. Irrigation Departments is necessary. Further, the problems relating to the rise of sub-soil water in Delhi are being dealt with by the C.P.W.D. The Committee understands that, apart from the matters which have been discussed in this report, there is the question of water supply which is engaging the attention of the Corporation. Within the Government of India, again, all these problems are dealt with under different Ministries. These are the Ministries of Home Affairs, Health, Irrigation and Power and Works, Housing and Supply. Such arrangements can neither be satisfactory nor conducive to speedy solution of these problems. The Committee, therefore, recommends that all these and other allied technical problems relating to the Union territory of Delhi should be handled by one Ministry and that, in its opinion, should be the Ministry of Home Affairs inasmuch as it is the Home Ministry that is administratively concerned with the affairs of Delhi and is in charge of the Delhi Administration, the Corporation and the N.D.M.C. This means that policies in regard to all the problems discussed in this report and also other technical matters should be formulated and co-ordinated in that Ministry.

7.7 In this task, the Ministry of Home Affairs will require consultation with and assistance of the technical Ministries concerned and the Ministry of Finance. For this purpose, the Ministry of Home Affairs can consult the other Ministries, and may set up a Co-ordinating Committee of Secretaries, consisting of the following :—

Secretary, Ministry of Home Affairs (Convenor).
Secretary, Ministry of W.H. & S.
Secretary, Ministry of Health.
Secretary, Ministry of Irrigation and Power.
Secretary, Ministry of Finance.

For problems, which require association and consultation with other Ministries of the Central Government and the Governments of Punjab and U.P., this Committee could also co-opt representatives of those Ministries and Governments as and when required.

7.8 The improvement to be carried out and the problems that have to be tackled are mainly of a technical nature. While the engineering organizations of the various agencies and departments will be directly responsible for the preparation of detailed schemes and executions thereof a good deal of co-ordination will be necessary among them and with the engineering organizations of the Punjab and U.P. Governments. Thus alone could effective planning be done on the basis of uniform standards and over-all requirements of Delhi as a whole. For ensuring this technical co-ordination and also to assist the Ministry of Home Affairs in taking policy decisions in regard to those technical matters, that Ministry should have the assistance of a Senior Technical Officer with one or two technical officers of lower rank under him. This officer will arrange for consultations when the schemes are in the process of preparation and will provide such guidance and direction, as may be necessary, and also intervene if any differences of opinion arise on technical matters between the various agencies. In order that this Technical Officer may be in a position to discharge his responsibilities adequately and effectively, he should be an officer of the rank and status of a Chief Engineer. It is further suggested that this officer should function as Secretary of the Secretaries' Co-ordinating Committee, referred to in the preceding paragraph, and could perhaps be designated as a Joint Secretary to the Govt. of India. It will be his duty to report to the Secretaries' Committee the progress of the implementation of various works from time to time and to put up to them such other schemes of a technical character that may require consideration at Government level and such difficulties and bottlenecks as he may be unable to resolve himself in consultation with the various technical organisations handling these problems under the different Ministries and local authorities.

SUMMARY AND ACKNOWLEDGEMENTS

8.1 The appointment of a committee to plan measures against floods and similar calamities in Delhi was decided upon at a meeting held on the 23rd July, 1958 under the chairmanship of the Prime Minister. The terms of reference were :—

(a) to consider protective measures from consequences of floods, heavy rains, etc.;

(b) to examine the adequacy of the existing drainage and sewerage systems and to suggest improvements ;

(c) to go into the problems of water-logging, low-lying land and sub-soil water ;

(d) to examine bridges, bunds, etc., from the structural point of view ; and

(e) to look into the matter relating to equipment, such as pumps etc., necessary to deal with emergencies.

The implementation of the decisions to be taken by the Committee was also its responsibility.

8.2 The terms of reference have been regrouped under the following heads :—

(a) Stormwater drainage
(b) Sewerage
(c) Problem of sub-soil water
(d) Flood protection works
(e) Equipment needed to deal with emergencies
(f) Administrative and financial matters.

STORMWATER DRAINAGE

8.3 The stormwater drainage system of the urban and rural areas has been considered separately. In respect of urban areas, the drainage system has been recommended to be remodelled for a storm likely to occur once in 2 years. This represents a rainfall intensity of 1·65" per hour. The run-off is to be worked out taking into consideration the intensity of rainfall corresponding to the time of concentration of the drain and also the proportion of built-up to unbuilt areas. In the case of rural areas, the consideration will be to limit the period of flooding of crops to 3 days for a storm of frequency of once in 5 years. The run-off corresponding to this is 10 cusecs per sq. mile.

8.4 For the purpose of investigation of the stormwater drainage, the Delhi State has been divided into 4 blocks on the basis of natural topography of land ;

Block No. 1 comprises the New Delhi area and areas on the south and is mainly drained by the Barapulla Nalla and its tributaries.

Block No. II comprises the rural areas of West and North Delhi, drained by the Najafgarh Drain and its tributaries.

Block No. III comprises the old Delhi city area.

Block No. IV comprises the Shahdara area.

BLOCK NO. 1

8.5 The improvements suggested to Block 1 will take the following forms :—

(a) Improving the intercepting arrangements in the pre-1939 colonies.

(b) Increasing the capacity of the existing drainage system in the pre-1939 colonies to take a run-off of ½" against the original design of ¼".

(c) Improving the outfall conditions in case of the post-1939 colonies where flooding occurred.

(d) Providing pumps in areas which cannot be drained by gravity.

(e) Increasing the restricted waterways under railway & road bridges wherever necessary.

(f) Desilting and re-sectioning of the open outfall nallas.

Action on (b) above should be taken on the basis of observations on the performance of the drainage system after removal of all the existing obstructions. The cost of all these improvements has been estimated at Rs. 2.37 crores.

BLOCK No. II

8.6 This comprises the catchment of the Najafgarh Drain and its tributaries, 508 sq. miles in extent. The flooding of the urban areas in this catchment was partly due to the inadequacy, under the present conditions, of the waterway under the bridge across the Deryala Nalla, a tributary of this drain. It is now proposed to remodel this bridge to provide an adequate waterway.

8.7 Regarding the rural areas of Alipur and Najafgarh Blocks, the proposal is to regrade the bed of the Najafgarh Drain in a reach of 10 miles as an immediate measure. For providing substantial interim relief, it is proposed to completely re-section this drain in a reach of 13 miles, increasing its bed width where the drain has a restricted waterway. For complete relief, it is proposed to provide a catchwater drain around the Jheel, improve the Najafgarh Drain throughout its length and regrade and divert the Manageshpur and Nangloi Drains. Before execution of this work, the desirability of draining the Jheel completely should be examined by the C.W. & P.C. in consultation with the Ministry of Food and Agriculture. In addition, pumping of arrangements will be required for certain low pockets as also improvements to a few other drains. The total cost of all these improvements is estimated at Rs. 1.7 crores.

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BLOCK No. III

8.8 Block No. III covers the Old Delhi city area. The problem here is the separation of sewerage from stormwater drains. The estimated cost of separation is Rs. 30 lakhs.

BLOCK No. IV

8.9 This comprises the Shahdara area. It is proposed to drain this area by gravity through suitable open channels running north-south, taking the rainwater to a point below the Okhla Weir where adequate fall in the river is reported to be available. As this scheme is based on a general study of conditions at site, detailed investigations are necessary before the necessity for pumping can be ruled out. The cost of this scheme has been estimated at Rs. 42 lakhs.

8.10 Summing up, the total cost of the improvements to the existing drainage system is Rs. 4·79 crores, *i.e.* Block No. I Rs. 2·37 crores, Block No. II Rs. 1·70 crores, Block No. III. Rs. 30 lakhs and Block No. IV Rs. 42 lakhs.

8.11 As the outlay involved is large and the implementation of all the works is likely to take considerable time, these works have been divided into 3 phases :—

(1) Works that should be completed before the next monsoon.

These are estimated to cost Rs. 19 lakhs.

(2) Works of an urgent nature which should be taken up for execution as soon as the investigation work is completed, and should be completed before the monsoon of 1960.

These are estimated to cost Rs. 129 lakhs.

(3) Remaining works which are estimated to cost Rs. 331 lakhs.

The Committee accepts the necessity for all these works and recommends their speedy execution. Before any further steps to augment the capacity of the drainage system of the pre-1939 New Delhi area are taken, the Committee would recommend that the performance of the system should be watched after the removal of all obstructions.

SEWERAGE

8.12 The urban areas of the Delhi State have been divided into 4 zones for the purpose of investigation of the sewerage system. These are the South-East Zone, the North Zone, the West Zone and the Shahdara Area. Reference may be made to Plan No. 3 for these zones.

SOUTH-EAST ZONE

8.13 This zone comprises the Old Delhi and New Delhi areas. Of the 3 trunk sewers serving this area, 2 are overloaded. Some of the branch sewers in the New Delhi area are also overloaded. The Old Delhi area is, at present, served by a combined system whereby stormwater also enters the sewers. The Okhla sewage treatment plant is no longer adequate to deal with the entire sewage flow and parts of the plant are also due for renewal. As a result, crude sewage overflows into the Jamuna at several places. Many of the outlying colonies are still unsewered. There are a number of subsidiary pumping stations involving a heavy recurring expenditure.

8.14 The Delhi Corporation is laying a relief trunk sewer from the Delhi Gate to the Ring Road. Certain additions are also being made to the Okhla treatment plant. Action is also being taken for providing sewerage to some of the unsewered colonies. The further improvements, which are necessary and which we recommend for execution, are :—

(a) Laying relief branch sewers in the New Delhi area.

(b) Extension of the new trunk sewer from the Delhi Gate to the Red Fort, duplicate rising main from the Ring Road Pumping Station to the high-level gravity duct and cross-connection between old and new sewers.

(c) Providing internal sewers in Civil Lines and Kotla Mubarakpur, outfall sewers for the Friends' Colony and Malvia Nagar.

(d) Additional secondary treatment plant at Okhla for 30 m. g. d. Extension of irrigation channels and renewal of machinery of the activated sludge plant.

(e) Gas utilisation works at Okhla.

(f) Elimination of subsidiary pumping stations.

(g) Separation of stormwater and sewage in the Delhi city area.

Excluding the last item, provision for which has been made in the stormwater drainage estimate, the cost of the schemes is estimated at Rs. 166 lakhs.

NORTH ZONE

8.15 This zone covers the urban areas in North Delhi, such as Karol Bagh, Subzi Mandi, Model Town, etc. Some of the colonies are sewered, some have septic tank arrangemnets and the rest are at present unsewered. Part of the sewage from the sewered colonies is pumped into the trunk sewers in the South-East Zone, further aggravating the overloading of the latter.

8.16 A new treatment plant, capable of dealing with the entire sewage of this zone, has been set up near the Coronation Pillar. The main trunk sewer to feed this treatment plant is also being laid. The further works, which are necessary and which we recommend for execution, are :—

(a) Additional secondary treatment units for 10 m.g.d. and gas utilisation works at the treatment plant.

(b) Extension of the trunk sewer from the Delhi-Ambala railway line up to the Old Rohtak Road.

(c) Branch sewers.

These are estimates to cost Rs. 81 lakhs.

WEST ZONE

8.17 This zone covers the urban areas of West Delhi. Excepting the Cantonment area, none of the colonies is sewered. A new treatment plant has been set up by the Corporation at Tilak Nagar to deal with the entire sewage and industrial wastes of this zone. One trunk sewer is being laid along Road No. 34 and the Najafgarh Road. The further works, which are necessary and which we recommend for execution, are :—

(a) Providing irrigation channels at the Tilak Nagar Plant.

(b) Laying a trunk sewer along the Najafgarh Drain.

(c) Laying a trunk sewer south of the Najafgarh Road parallel to the railway line.

(d) Branch sewers.

These are estimated to cost Rs. 88 lakhs.

SHAHDARA AREA

8.18 The entire Shahdara Area is at present unsewered. Due to development difficulties, it will not be easy to provide underground sewerage in this zone immediately. As an immediate measure, we recommend the setting up of two night-soil digestion tanks at an estimated cost of Rs. 7·6 lakhs. The pace of development is, however, likely to quicken in the near future and it will not be long before we shall have to think of providing sewerage arrangements. The probable cost of providing sewerage facilities, complete with purification works, has been estimated by the Corporation at Rs. 1·39 crores.

8.19 Summing up, the total cost of improvements to sewerage is Rs. 4·82 crores as shown below:—

(a) South-East Zone	Rs. 166 lakhs.
(b) North Zone	Rs. 81 lakhs.
(c) West Zone	Rs. 88 lakhs.
(d) Shahdara Area	Rs. 147 lakhs.
	Rs. 482 lakhs.

The Committee recommends the phasing out of the works on the basis of priority. A suitable phasing is suggested in Appendix VIII.

THE PROBLEM OF SUB-SOIL WATER

8.20 The *Ad Hoc* Committee on Sub-soil Water has finalised its study of the causes of the rise of sub-soil water and suitable measures to lower it.

It has divided the New Delhi area into 3 zones :—

Zone I: The areas where the sub-soil water table in October is within 6′ from the ground surface. These are termed as 'Badly Affected'. These are the areas where the maximum damage to buildings, roads and vegetation can take place as a result of water-logging.

Zone II: This zone, termed as "Moderately Affected" areas, covers the areas where the water table is 6′ to 10′ from the ground surface.

Zone III: Areas where the water table in the month of October is at a depth greater than 10′ from the ground surface.

8.21 From the Iso-hydrographs drawn every year, it is observed that more and more areas under Zone III are passing into Zone II and, similarly, areas from Zone II are passing into Zone I. The statement given below indicates the alarming rate at which large areas of land, which were "safe", have passed on to what are termed as "moderately" and "badly" affected areas.

Sr. No.	Depth of water table from ground in October	Area in acres in Oct. 1954	Area in acres in Oct. 1955	Area in acres in Oct. 1956	Area in acres in Oct. 1957	Area in acres in Oct. 1958
1.	Within 6′	256	545	920	1,040	3,200
2.	From 6′ to 10′ . .	3,114	3,415	3,470	3,930	6,000
3.	More than 10′ . . .	6,430	5,840	5,410	4,830	600

Apart from this, the other conclusions that have been reached are as follows :—

(1) The sub-soil water table rises from June to October.

(2) It falls from October to June but there is generally a net rise from June to June.

(3) Heavy rainfall is responsible for the abnormal rise during the monsoon period.

(4) Since 1912, there has been a general rise in the sub-soil water table, varying from 1·67 feet to 15·87 feet.

(5) The net annual rise of sub-soil water is the least in the case of badly affected areas, and is the maximum in the case of "safe" areas.

(6) Whether a state of equilibrium has been reached in the badly affected areas is difficult to say. A final conclusion on this point will be possible only when the results of observations for a long period are available.

8.22 According to the *Ad Hoc* Committee, the rise in sub-soil water is due to additions to the underground water table by way of percolation or seepage.

The sources of percolation or seepage are :—

(*i*) Holding up of stormwater due to urbanisation ; and

(*ii*) Irrigation.

8.23 According to the *Ad Hoc* Committee, a high water table is harmful to buildings and vegetation. It has, therefore, recommended that the sub-soil water table should be lowered to a depth of 10′ below the ground level in October and to 14′ in the pre-monsoon period. It has also confirmed that such lowering is not likely to have any harmful effect on the existing buildings. The remedial measures suggested are :—

(*a*) Improvement of the drainage system.

(*b*) Economy in the use of unfiltered water.

(*c*) Physical removal of water from the sub-soil reservoir by tubewells.

(*d*) Supplementing the underground drainage by laying porous drains in areas to be taken up for development.

8.24 The *Ad Hoc* Committee has ruled out the possibility of utilising tubewell water for irrigation purposes due to its high salinity. It has also recommended the reclamation of areas, which have become saline due to the presence of salts caused by fluctuation in the water table, by using D. D. T. or gypsum.

8.25 The *Ad Hoc* Committee has also recommended further continuance of studies on the behaviour of the sub-soil water table.

8.26 Without taking into consideration the cost of improvement to drainage, the cost of various remedial measures suggested for lowering and stabilising the water table has been estimated at Rs. 30 lakhs.

8.27 This Committee accepts the various recommendations of the *Ad-Hoc* Committee on Sub-soil Water and recommends their speedy implementation.

FLOOD PROTECTION WORKS

8.28 Flood protection works in the Delhi State consist of a series of bunds on both sides of the Jamuna. Improvements to these bunds have been carried out from time to time. During the floods of 1956 to 1958, it has been observed that the right side bund from the Coronation Pillar to the Shah-Alam Bridge and the left Marginal Bund need strengthening. A new weir is under construction at Wazirabad, as a result of which the high flood level upstream of the weir will rise further, necessitating raising of the bunds upstream of the weir. Schemes for raising and strengthening of the bunds have been finalised, estimates sanctioned and the works taken in. hand. The Committee would, however recommend that the top width of the Shahdara Bund, after raising, should be 24 against the proposed width of 15′.

8.29 The villages between the river and the bunds are unprotected from floods. A proposal has already been finalised to shift these villages to the land side of the bunds. We recommend early implementation of this proposal.

8.30 Low-lying areas on either side of the Barapulla Nalla between the railway track and the Ring Road are also subject to flooding. To remedy this, it is proposed to provide bunds on either side of the Barapulla Nalla in this reach and the cost of this scheme is included in the suggested improvements to stormwater drainage. We recommend early completion of investigation and implementation of this proposal.

EQUIPMENT

8.31 The equipment required has been subdivided into:—

(*a*) Equipment for execution of the various schemes.

(*b*) Equipment to deal with emergencies.

8.32 The equipment required for execution are well point equipment for the Delhi Municipal Corporation and two drag line excavators for the C. P. W. D. These are estimated to cost Rs. 9 lakhs.

8.33 The Delhi Municipal Corporation has already made arrangements for procuring the necessary equipment to deal with emergencies in its areas. The N. D. M. C. has, however, yet to procure such equipment for the areas under its jurisdiction and the cost of these is estimated at Rs. 80,000/-.

We recommend immediate procurement of this equipment.

ADMINISTRATIVE AND FINANCIAL MATTERS

8.34 The Improvements suggested would involve a total financial outlay of Rs. 10·05 crores. The allocation of costs, according to the fields of responsibility, would be as follows:—

(i)	Delhi Municipal Corporation	Rs. 613 lakhs.
(ii)	N.D.M.C.	Rs. 202 lakhs.
(iii)	Delhi Administration	Rs. 154 lakhs.
(iv)	Ministry of W.H. & S.	Rs. 36 lakhs.
		Rs. 1,005 lakhs.

8.35 The local bodies may find it difficult in the immediate future to raise such large amounts from their own resources. We, therefore, recommend that, if they approach Government for assistance, such assistance should be rendered by way of loans and grants, as may be necessary.

8.36 For carrying out investigations, we recommend that the Corporation should strengthen its field engineering organisation. As regards the N.D.M.C., we recommend that the C.P.W.D. should render such assistance to it as it may require and as Government may approve. As an interim measure, we recommend the continuance of the existing set-up under the C.P.W.D., the Corporation and the C.W. & P.C.

8.37 Apart from the technical problems of the Delhi State, dealt with by this Committee, there are also other technical problems of Delhi, as for example, the problems of water supply. We recommend that the responsibility for the formulation of policies and ensuring co-ordination in regard to all such problems should rest with the Ministry of Home Affairs.

8.38 In order to assist the Ministry of Home Affairs in these technical matters and for purposes of securing necessary co-ordination, we recommend the setting up of a Committee of Secretaries of the Ministries concerned dealing with these technical matters. This Committee should be further assisted by a wholetime technical officer of Chief Engineer's rank, functioning as Secretary of this Co-ordinating Committee.

8.39 The Chairman wishes to place on record his keen appreciation of the work done by the Technical Committees and the *Ad Hoc* Committee on Sub-soil Water problems under the chairmanship of Shri J. M. Rijhwani. These Committees had to work at great speed, have investigations carried out in the field, and discuss the various problems among technical experts and advise the main Committee from time to time on measures that are necessary to deal with the problems which are the subject matters of this report. He is grateful to the members of the Committee and S/S Walter George and Karnail Singh, the Chief Engineers and their officers from the Punjab and U. P. for their keen interest in the deliberations of the Committee and their help and co-operation. While discussing the sub-soil water probelms, the Committee had the valuable assistance of Prof. Dr. Janert of the Greifswald University in Germany. The Committee also had the benefit of the advice of Shri C. K. Nair, M.P., and Shri Brijkrishan Chandiwala, Convenor, Bharat Sewak Samaj, while discussing the problems of the Najafgarh area. The Chairman would like to place on record his grateful thanks to all these gentlemen for their co-operation and help.

(Sd/-) K. C. REDDY
Chairman.

(Sd/-) M. R. SACHDEV
Convenor.

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APPENDIX I

FIRST REPORT OF THE COMMITTEE FOR PLANNING MEASURES AGAINST FLOODS AND SIMILAR CALAMITIES IN DELHI

I

INTRODUCTION

An all-time record rainfall of more than 10·5″ in 24 hours (with a maximum of 2·8″ in one hour) on 20th and 21st July 1958 flooded large areas in the Capital causing some damage to roads and buildings and paralysing communications. The Prime Minister called a meeting on 23rd July of the Ministers concerned, the Mayor of Delhi and other civil and military officers to consider the situation that had arisen and, after discussions, decided to set up a Committee for planning measures against floods and similar calamities in Delhi. The Committee consisted of the following :

1. Shri K. C. Reddy, Minister for W. H. & S. (*Chairman*).
2. Secretary, Ministry of Rehabilitation (Shri Dharma Vira).
3. Secretary, Ministry of Health (Shri V. K. B. Pillai).
4. Chief Commissioner, Delhi. (Shri A. D. Pandit).
5. Shri P. R. Nayak, Commissioner, Delhi Corporation.
6. Chief Engineer, C.P.W.D. (Shri J. M. Rijhwani).
7. Financial Adviser, Ministry of W. H. & S. (Shri S. Vohra).
8. Shri G. Mukharji, Chairman, Town Planning Organisation.
9. A representative of the Central Water & Power Commission (Shri Kanwar Sain, Chairman).
10. Drainage Engineer, Delhi Municipal Corporation (Shri M. A. Lokhande).
11. Maj. Genl. R. E. Aserappa, Engineer-in-Chief.
12. Shri M. R. Sachdev, Secretary, Ministry of W. H. & S. (*Convenor*)

The Committee co-opted Shri Walter George and also invited Shri Karnail Singh, Member, Railway Board to assist the Committee in its deliberations from time to time.

TERMS OF REFERENCE

The Committee was to deal with short-term projects and also consider related long-term schemes. Implementation of the recommendations was also the responsibility of this Committee. Its terms of reference were :

1. to consider protective measures from consequences of floods, heavy rains etc. ;
2. to examine the adequacy of existing drainage & sewerage systems and to suggest improvements ;
3. to go into the problem of water logging, low lying land and subsoil water ;
4. to examine bridges, bunds, etc. from structural point of view ; and
5. to look into the matter relating to equipment, such as pumps etc. necessary to deal with emergencies.

The Committee has held four meetings so far and copies of the minutes of the first three meetings are attached (Annexures I to III). At its fourth meeting held on 9th August, the Committee approved of this first interim report. The Committee, had set up three sub-committees, one to deal with urgent and emergent repairs, another to suggest short and long term remedial measures and the third to ensure that there were no administrative and financial bottlenecks in the implementation of the proposals and the schemes, which had the approval of the Committee. The first two technical sub-committees have had several meetings and taken action to carry out urgent works and implement other decisions.

The Chairman and several members of the Committee have visited many of the flood affected areas and have inspected the storm water drains and bunds.

II

CAUSES OF THE FLOOD

Before the construction of the New Delhi Capital the whole estate was an open country with some cultivation subsisting on wells or on rains. At times of heavy rainfall there was no obstruction to the run off. Two big natural drains carried away practically all the run off of the cultivated and uncultivated areas. With the building up of the Capital these natural drainage lines and channels were blocked and artificial drains were provided to carry away storm water from the built up area. The original stormwater drainage was designed and built in 1918 for a ¼″ run off (which means that only 1/4″ of rain water per hour finds its way into the storm water drains) except for the then Viceregal Estate and the Secretariat area which was designed for 1″ run off. This design was based on the engineering practice then obtaining and the meteorological data available at the time.

The following extract from the report of the Meteorological Office gives details of the heavy rainfall on 20th and 21st July and compares it with the heavy rainfall on two previous occasions in 1936 and 1954.

> "For the 24 hours ending at 8·30 A.M. on 21st, a rainfall of 10·5″ (26·6 cms) was recorded in the Lodi Road Observatory. This is an all time record of 24 hours rainfall for Delhi ; the previous record being 9·27″ recorded on 28th June, 1936.
>
> The rain commenced on the 19th and continued intermittent throughout the 19th and upto 4 P.M. of 20th. For the 24 hours ending at 08·30 I.S.T. of 20th 2·4 cms (nearly 1″) of rain was recorded. From 08·30 to 1600 of 20th, 42 m.m. (1·7″ nearly) of rain fell. There was a break in the rain thereafter upto 11 P.M. after which moderate to heavy rain set in and continued upto 0645 hours of 21st. The intensity was very high between 0245 and 0500 hours and again from 0530 to 0615.

Rainfall from . . .	1100-0245	28 m.m. (1·1″)
Rainfall from . . .	0245-0500	120 m.m. (4·8″)
Rainfall from . . .	0530-0615	25 m.m. (2·2″)

The maximum rainfall in one full hour during this period was 70 mm (2·8″) from 4 A.M. to 5 A.M. of 21st.

Average intensity during the period 0245-0615 was 53 m.m. per hour or 2·1 inches per hour.

The maximum intensity of rainfall during short period of 3 minutes during the heavy spell was 3·4″ per hour.

Previous occasions of such heavy rain.

(1) On 28th June, 1936, rainfall of 9·27″ was recorded in Delhi. This was an all time record from 1881 onwards upto that year. This year's 10·5″ has thus beaten the previous record. Details of the 1936 rainfall are not available.

(2) From the noon of 30th September to 3 P.M. of 1st October, 1954, Delhi recorded rainfall of 9·36″. This heavy fall also occurred in association with a late monsoon Depression. But the maximum hourly rainfall was of the order of 1·5 inches to 1·6 inches while short period intensity (5 minutes) was about 3·5 inches per hour.

As the ground was already fully soaked by previous showers, most of the water found its way into the drains which were only designed for ¼″ run off. These drains obviously could not clear a discharge far in excess of the designed capacity and hence the flooding of areas became inevitable.

The problem is to consider for what intensity of rainfall should the drainage system in Delhi be designed. The total rainfall of 10·5 inches (26·6 c.m.) in 24 hours, with an intensity of 2·8 inches in an hour, on 20th/21st July, 1958, was not experienced since 1881. There have been cloudbursts in 1936 and 1954 but the maximum hourly intensity did not exceed 1·6 inches. The drainage is primarily affected by the intensity of rainfall, and the intensity as on 20th/21st July, 1958 may not be expected for a long time to come. Provision of drainage system for such unusual cloudbursts, which may only occur very rarely, is therefore not a justifiable proposition on account of the excessive costs, both initial and recurring. There is no doubt that a certain amount of calculated risk has to be taken in not designing the drainage system to meet the requirements of the heaviest rainfall so far recorded or ever expected. This accords with the accepted principles of design in practice everywhere.

The *Ad hoc* committee on subsoil water level (referred to separately), at its meeting on 5-8-1958, considered afresh the question of what "run-off" should be adopted for the drainage system in the light of the experience of the recent rains in Delhi. On the basis of a study made by the officers of the Meteorological Department on the intensity, duration and frequency relationships of rainfall at selected stations in India upto 1955, a rainfall intensity of 1·71 inches per hour can occur in Delhi with a probability of once in 10 years. The Committee have held that this should be the maximum intensity for which the drainage system should be designed. As the total rainfall does not always find its way into the drains, it is essential to determine the actual "run-off" into the drainage system as a co-efficient of the total rainfall. After careful study, the *Ad hoc* committee has suggested that the co-efficient of "run-off" in an area like New Delhi should be between 0·25 and 0·5. This is a very important matter; the recommendations of the *Ad hoc* committee and views of other authorities that may be received will have to be carefully considered by the Committee, before a final decision is taken.

III

AREAS FLOODED AND THE EXTENT OF DAMAGE

As has been explained above the drains were not able to cope with the discharge consequent on the unprecedented rainfall on 20th and 21st July, thus resulting in the flooding of low lying areas. Some of the areas that were flooded within the limits of New Delhi and the Delhi Corporation are mentioned below :

(*a*) low lying areas like the Gole Market, Parliament Street, parts of Ashoka Road, Talkatora Road, Old Mill Road, Raisina Road, Queen Victoria Road, York Road, King Edward Road, Central Vista and the Golf Link area,

(*b*) Places where the open Nullahs overflowed their banks like the Lajpatnagar Nullah affecting Lajpatnagar and Jangpura ; the Hardinge Bridge Nullah affecting Indraprastha Estate ; the Dariya-e-Nullah (Ganda Nullah) affecting areas near Rohtak Road ; and the Najafgarh Nullah affecting built up areas such as the University Enclave, Rana Pratap Bagh, Model Town, Vijayanagar, etc.,

(*c*) depressions like the Minto Road Subway,

(*d*) areas like Shahdara, Gandhinagar and Gita Colony on the left bank of the River Yamuna.

A plan showing the various Nullahs will be found at the end.

As a result of the heavy rains, flooding also occurred in the Krishi Bhavan on the Queen Victoria Road ; the All India Radio building on Parliament Street ; and the Telephone Exchange building in Connaught Place, resulting in the dislocation of telephonic communications. There has, however, been no damage to any of these buildings.

The 27 feet high approach road to the recently built overhead railway bridge on Delhi Mathura Road settled down by about 1½′ in a length of about 100′. The torrential flood water also scoured out one of the side slopes of the high embankment in a length of about 95′. There was, however, no damage to the bridges. The damage caused to the road is estimated at less than Rs. 5000/-.

A detailed statement showing the areas that got flooded, the damage, as far as known, and the steps taken or proposed to be taken to meet the situation in each case, is attached as Annexure IV. The information in respect of damage to private properties, which suffered in varying degrees is not available. A large number of old and dilapidated houses in old Delhi suffered a partial or complete collapse resulting in some loss of life and injury to persons. Fourteen lives are reported to have been lost in house collapses and by drowning and electrocution etc.

IV

WORK OF THE TWO TECHNICAL SUB-COMMITTEES (A AND B)

The Sub-Committee, A, to consider the problem of emergent repairs and maintenance of stormwater drains, has had 3 meetings so far, and copies of the minutes of the meetings are enclosed (as Annexures V, VI and VII). At the first meeting, the Sub-Committee took stock of the existing drainage arrangements in New Delhi and Delhi areas and detailed different officers of the C.P.W.D. and the Delhi Corporation to inspect the various drains and to submit reports on emergent repairs required to be carried out. The drainage system of New Delhi consists of open drains into which drain the surface water from the roads through gullies and from open areas by surface flow. These open drains discharge into covered drains which, in turn, discharge into various open Nullahs joining the river at various places. The inspections, which were carried out after the floods showed that most of the drains functioned to the limit of their designed capacity but because of the unprecedented rains, a number of the Nullahs into which these drains discharged overflowed, resulting in some breaches and flooding of the low lying areas. In some cases, the breaches in the Nullahs resulted from artificial cuts made by the people living in low lying areas near the drains.

The officers concerned were authorised to carry out immediate repairs to banks, to close breaches and remove obstructions etc. These emergent works have already been completed.

Details of the works carried out are indicated in Annexure VIII.

In addition to these emergent repairs, other urgent works to improve the drainage of Delhi were considered by the Committee as explained below :

1. Proposals have been finalised for regarding of the intercepting drain along the ridge (upper reaches of Kushak Nullah). This should prevent to a considerable extent flooding of the Gole Market area.
2. Widening of the culvert across the railway line and re-modelling of the two road bridges nearby over the drain from Lajpat Nagar.
3. Regarding Dariya-e-Nullah which affected areas along Rohtak Road near Sarai Rohilla, it has been decided that an extra opening should be provided for the sewer line which goes through the Railway culvert.

It has also been decided that immediate investigation should be undertaken in connection with the regarding of the Nullah and to provide separate drainage for the low lying area between the Rohtak Road and the railway line.

4. It has been decided that the culvert over the drain in the Friends Colony should also be widened. This work will be done by the Central P.W.D. on behalf of the Corporation.

The Second Technical Sub-Committee

The Sub-committee B has also had 3 meetings ; first on 25th July, second on 30th July and the 3rd on 8th August. Copies of the minutes of the first two meetings are enclosed (as Annexures IX and X).

This Committee is required to suggest short and long term measures for preventing flooding of New Delhi and Delhi areas. The Committee has decided the lines on which investigations for the long term measures should be carried out and is collecting the following technical data for the purpose :—

1. Contour plan of the entire Delhi area.
2. Complete rainfall data, maximum intensity of rain and time of concentration.
3. Investigation of the existing drainage system.
4. Design data of the existing drains.
5. Theoretical check of the existing drains.
6. Site check of the existing drains.
7. High flood level of nallahs and high flood of river at these junctions.
8. Hydraulic data of the Railway and roads bridges crossing the various outfall nallahs.
9. Indication of low lying areas which cannot normally drain into any of the existing drainage systems and from which water will have to be pumped out.
10. Causes of improper drainage and remedial measures.

The necessary data regarding the existing drainage system in New Delhi area is already available. A considerable amount of work has already been done by the *Ad hoc* Committee on subsoil water level on the existing drainage arrangements in New Delhi area. The deficiency in the existing drainage system and remedial measures to be undertaken have also been indicated by this committee. No such data is, however, so far, available in respect of the Old Delhi area.

Necessary staff to assist this Technical Sub-Committee in carrying out the necessary detailed survey is being placed at its disposal.

The Sub-Committee has also considered short term measures to prevent flooding of areas like the Minto Road Bridge, the Telephone Exchange, the Queen Victoria Road Office Building and the Indraprastha Estate.

Minto Road Bridge

The flooding of the Minto Road bridge which was constructed some 30 years ago is due to the ingress of rain water from the adjoining built up areas into the depression under the bridge. The Railways have already taken action to improve the drainage of the railway yard both on the East and the West side of the railway line. Steps are being taken to improve the general drainage of other areas on both sides of the bridge. A hump will be provided on the Minto Road side of the bridge similar to the one that exists on the Connaught Place side.

The pumps installed at the bridge are only capable of dealing with the flow of the subsoil water into the depression. In order to meet the situation during the rains, it has been decided to increase the pumping capacity and to have vertical type pumps. In the meanwhile action has also been taken to ensure that the Pump House is not flooded.

Telephone Exchange

Proposals have been formulated for the drainage of this area by the *Ad hoc* Committee on Subsoil Water but as this will be a long term measure, a fresh scheme has been prepared for providing a temporary drain to drain off this area.

In addition, action to seal off the multi-storeyed buildings, like the Krishi Bhavan, the All India Radio Buldg., the Telephone Exchange and other buldgs. in the Indraprastha Estate area has also been taken. The annexure at IV gives details of flooding of the basements of these multi-storeyed buildings.

Maintenance of the Drainage System

The Committee has emphasized the need for a high standard of maintenance of storm water drains. At present, the storm water drains of New Delhi area are maintained by the N.D.M.C. and the drainage system of Old Delhi is under the maintenance of the Corporation authorities.

There should be a separate set-up under the respective local bodies for efficient maintenance of these drains. In respect of the New Delhi area the drains should be examined by the senior Engineer of the C.P.W.D. and a report on the condition of the drains should be submitted to the Ministry of WH&S through the Chief Engineer with a copy to the Ministry of Health. Similarly in respect of the drains in the Old Delhi area the Corporation Engineer will submit a report on the condition of the drains to the Health Ministry through the Commissioner of the Corporation with a copy to the Ministry of WH&S.

These drains should be carefully examined by the appropriate authorities in the month of October each year. Action should be taken to desilt and carry out repairs to the storm water drains wherever necessary during the winter months and an inspection should again be made in the month of April, to ensure that the necessary repairs, required to be carried out, have been done and the drains are in good order. Such systematic annual inspection will ensure the efficient functioning of the storm water drains during the rains.

Maintenance of the Sewerage System

The position regarding the Sewerage System in Delhi is that in the area within the city walls, there are combined sewers-storm-water drains. The capacity of these is not adequate even to carry the sewage, and when they have to carry a large quantity of water during rains, they overflow and even burst at places, causing flooding, nuisance and insanitation. The Old Delhi system is connected to the trunk sewer from Delhi Gate to Kilokri, which also carries sewage of New Delhi. Owing to the increase in population during the last 10 years, the capacity of this trunk sewer is entirely inadequate and the scheme for building another trunk sewer from Delhi Gate to Ring Road, from where it will be pumped to the Okhla Sewage Disposal Works is in hand. At present the mote along the city wall has to carry some of the sewage from the city. When the additional trunk sewer is in position, this nuisance will be stopped and the mote will be used only for storm water. It is also necessary gradually to build two separate storm water drains for Old Delhi to relieve the pressure on the existing combined system. The Corporation will have to undertake quite heavy capital expenditure for this purpose during the next few years.

It is well known that many of the rehabilitation colonies were built and occupied without completing the arrangements for the disposal of human wastes. The Improvement Trust created an industrial area on Najafgarh Road in 1937 in which several factories have sprung up without making any arrangements for water supply or sewerage. The whole of the sewage from West Delhi as well as portions of Old Delhi finds its way into the Najafgarh Nala, which was originally intended to be a storm water drain. The Corporation is laying a trunk sewer along the Najafgarh Road and has already erected a sewage disposal plant at Keshopur. It will be necessary to provide another trunk sewer along the Najafgarh drain. Tenders for this work also have been invited by the Corporation. New developments, such as Friends' Colony, on both sides of the Mathura Road in recent years have also not been provided with sewerage facilities. Another trunk sewer will therefore be necessary from Friends' Colony up to the Ring Road Pumping Station to pick up the sewage from both sides of the Mathura Road and the Bara Pula Nala. This will also reduce the danger from flooding as well as the nuisance from sick soakage pits in the Friends' Colony area.

The problem of Shahdara, where extensive development—both private and by the Rehabilitation Ministry—has taken place after Independence, does not admit of an easy solution owing to the fact that by and large Shahdara is set in a trough, bounded by the Hindan and Yamuna Rivers, the Northern Railway embankment and the diversion channel on the other two sides, with no outlet for the storm water to flow by gravity into either of the rivers. A preliminary survey shows that the southern part is sloping generally towards the Hindan Cut, and if the obstructions to the free flow of water are removed and the flow canalised, it may be possible to drain a large percentage of the storm water by gravity into the river Yamuna below Okhla.

As regards sewerage, Shahdara is at present entirely served by the dry system, as it has neither sewer nor water-supply system. Supplying filtered-water to Shahdara is itself a difficult problem, which is not expected to be solved for some years. It would be of no use putting underground sewer until a sufficient quantity of water-supply at a fairly high pressure can be ensured. Moreover, even if a piped water supply is available for Shahdara, installation of a modern method of sewage disposal will be comparatively costly here, as owing to the peculiar nature of the topography, more than one sewage disposal plant and pumping station will be necessary. In the first instance, however, the Corporation proposes to instal a sludge digestion plant, which will work in conjunction with the present dry sytem so that the disposal of night soil may be freed from nuisance and danger to health.

As regards sewage disposal plants for areas other than Shahdara, primary and secondary treatment plants have been installed at Keshopur for West Delhi and in Coronation Plant for North Delhi. For the south, an additional plant is being created at Okhla, but the present scheme does not provide for the secondary treatment.

As regards the cleaning and maintenance of sewers, the Delhi Corporation have two sewer cleaning machines and four pumps with necessary staff for cleaning sewers and they have five more machines on order along with six pumps.

The Committee has not been able so far, to examine the internal sewer system of the City. The Committee proposes to go into the questions referred to above at its future sittings, as also into questions relating to the sewerage in Rehabilitation Colonies and in old areas such as the University enclave, Kingsway Camp, etc.

V

PROBLEM OF WATER LOGGING IN LOW LYING LAND AND SUB-SOIL WATER

The Government of India had appointed an *Ad hoc* committee to investigate the sub-soil water problem in New Delhi. This Committee was appointed in 1953 and its terms of reference were to examine the question whether the sub-soil water table in New Delhi area was rising, and if so, to suggest what, if any, protective measures were necessary to safeguard buildings and structures in New Delhi. A brief resume of the work done by this Committee is given below.

The Committee has held twenty meetings apart from the meetings of the various Sub-Committees appointed for the investigation of specific problems.

The Committee could not proceed with this work expeditiously as there was no data or observations available when it started. Soon after the completion of the New Delhi Capital, the C.P.W.D. installed some observation pipes and started recording sub-soil water levels. During World War II, these observations were suspended, and many of the pipes got rusted and choked. The Committee decided that fresh observation pipes should be installed, spread over the whole of New Delhi and observations taken every fortnight. In addition, a mass of data required by the Committee had to be collected from old records, site survey, etc. A Special Division was created to carry out all the surveys and experiments, and make observations. It was this Division's function to process the data in the form of maps, diagrams and charts and to provide complete information for the consideration of the Committee.

The detailed examination of the data provided by the Central P.W.D. established that

(1) the water level in the river has little influence on the fluctuation of the sub-soil water table,

(2) the sub-soil water table rises from June to October and falls from October to June. Heavy rain falls during the monsoon are responsible for an abnormal rise leading to a net permanent rise in the level, and

(3) since 1912 there has been a general rise in sub-soil water table varying from 2 to 17 ft.

The *Ad hoc* Committee submitted an interim report in 1956, and a copy of its report is added as Annexure XI. Since then the Committee has pursued further studies 'and research work and also given consideration to the schemes for lowering sub-soil water level by improving drainage and pumping out water.

In the instance of the *Ad hoc* Committee the Road Research Institute have completed their study of the problem of differential settlements of buildings as a result of the lowering of the sub-soil water table. This report has been considered by the Committee, and its recommendations accepted. The conclusions briefly are that the possibility of appreciable surface subsidence occurring in the unbuilt areas as a result of dewatering is ruled out. For the built up areas in the case of the existing buildings, by and large the resulting differential settlement due to lowering of water table to 10 ft. below ground level will be insignificant. (Repeated fluctuations of the water table may, however, cause a settlement of the order of ½ inch in the case of a few foundations which rest upon sand. All though this magnitude of settlement is within allowable limits, it is advisble that pumping should be so arranged that frequent fluctuations within a depth of 10 ft. below ground level are avoided as far as possible.)

The Geological Department have carried out a study and have submitted a report. They have asked for further facilities for continuing their study to prepare a Geological map of the Delhi area.

On the basis of the information, derived from studies made by the Meteorological Department, the Committee have adopted certain coefficients for the built up area in New Delhi. Using these coefficients they have arrived at the figure of ·5 inches per hour run off (on an average) for designing the drainage system of New Delhi. A report of the Committee meeting held on 5-8-1958 is attached as Annexure XII.

Further action has been taken by the Committee as follows:—

(1) 16 tube wells have been installed in the badly affected area where the water table in the month of October is at a depth less than 6 ft. from the ground surface. These tube wells are working already. To start with pumping was restricted to a few hours per day. During the month of June 1958, 2·24 million gallons of water were pumped out from the sub-soil. Pumping is now being increased to 22 hours per day. Careful watch is kept on the saline content of the tube well water so that if suitable, this could be utilised for irrigation purposes. Generally, however, the water is brackish.

(2) A line of porous concrete pipes 10 ft. below ground level has been laid in the Central Vista. Pumping has been continuous. Before the heavy rain of July, it was possible to lower the water table to a depth of 8 ft. Pumping is now being increased to remove the excessive quantity of water received as a result of the heavy rain fall.

(3) Preliminary experiments on the reclamation of salt and alkaline patches in the Central Vista with the help of D.D.T. waste have been carried out. With the experience gained, a scheme for the reclamation of all saline and alkaline patches is being prepared.

On the recommendations of the Committee a complete scheme for improving the surface drainage of the New Delhi area, lowering of the sub-soil water in the badly affected and the moderately affected areas and preventing the rise of sub-soil water level in the unaffected and the new colonies has been prepared and the necessary estimates are being submitted to the Government of India.

The salient features of the complete scheme are :—

(1) Installation of tube-wells in the moderately affected area and in badly affected area.

(2) Regrading and regrassing the lawns of the Central Vista.

(3) Providing relief drains to the underground drainage system in New Delhi area.

(4) Regrading and redesigning of the drainage system of the New Delhi area where necessary.

(5) Providing complete Porous concrete drains in the Central Vista.

(6) Economic use of unfiltered water in lawns and gardens, and use of sprinklers in some selected areas as an experimental measure.

The *Ad hoc* Committee has compiled a mass of very useful data plotted on charts, diagrams, etc., for ready reference. Observations and studies on various aspects of the problem are continuing and the diagrams and charts are kept up-to-date.

The Committee proposes to consider the recommendations of the *Ad hoc* Committee to ensure that such of its recommendations as are accepted are speedily implemented and to watch the progress of its work from time to time.

VI

BUNDS AND BRIDGES AND SUMMARY OF ACTION TAKEN

Bunds:

The Committee directed that the existing bunds along the river Yamuna should be examined by the C.W.P.C. along with the officers of the C.P.W.D. and the Corporation. A report on the condition of the river bunds has been received by the Committee and necessary repairs and improvements have also been undertaken.

A system of inspection of these bunds should be established and the S.E., Delhi State Circle through the Chief Commissioner of Delhi should submit a report to the Ministry of Irrigation and Power with a copy to the Ministry of W.,H. & S. every year in the month of April on the condition of the bunds. Similar action should be taken by the S.E., Agra Canal (U.P. Irrigation) for the marginal Bund on the left bank of the Yamuna under his charge. The bunds should be maintained to the standards prescribed by the C.W.P.C. in terms of the Embankment Manual prepared by the Flood Wing of the C.W.P.C. in 1956.

Bridges:

Most of the nallahs that drain the rain water of Delhi into the Yamuna, cut across the Railway line and in many places, the road embankments also. The adequacy of the existing waterways across the Railway line as well as the Roadways is a matter for detailed investigation and has to be considered as a part of the long term measures. As already indicated in previous paragraphs, wherever the drains did not function properly on account of restricted waterway, the authorities concerned have been requested to increase the size of the openings on a priority basis.

Normally where levels are satisfactory there will not be any need for pumping out stormwater. Pumping of stormwater will be necessary only in cases of low lying areas, which cannot discharge into the nallahs or into the river during high flood level. Such areas are to be dealt with separately. Wherever possible, the drains should function by gravity, as pumping will not be an economical process. The Technical Sub-Committee B is already seized of the problem and will take this aspect of the matter into consideration when formulating short and long term remedial measures.

To sum up—

(*a*) urgent repairs by way of removal of obstructions closing of breaches, strengthening of bunds, etc., wherever necessary, have already been carried out or are in hand,

(*b*) suitable short term remedial measures have been taken to prevent the flooding of the strategic points, like the Minto Road Bridge, the Telephone Exchange, the Krishi Bhavan and the buildings in the Indraprastha Estate,

(*c*) the Committee has prescribed a procedure for the standard of maintenance of stormwater drains for the future. A system of strict inspection of drains before and after rains will be insisted upon, (*d*) the entire existing drainage system in New Delhi and Old Delhi will have to be examined in the light of their adequacy for higher discharge. This is being done. The existing size of the drains will not be able to cope with heavy rains likely to occur say once in 10 years,

(*e*) as a short term measure the Committee has already approved proposals for the regrading of Nallahs and widening of bridges wherever required without waiting for long term remedial measures,

(*f*) the Committee has directed the *Ad hoc* Committee on Sub-soil water to make its final recommendations and also to proceed expeditously with the schemes already formulated by them for the lowering of sub-soil water level,

(*g*) the river bunds have already been inspected and action taken to strengthen them, where called for, and

(*h*) action to remodel or widen some of the existing openings across Railways and roads, is being taken on a priority basis.

VII

FLOODING OF THE RURAL AREA OF DELHI

The main drainage of the rural area *i.e.* the Najafgarh Block and the Alipur Block is carried by the Najafgarh Nallah. The two main drains, which drain into the Najafgarh from the Alipur Block and part of Najafgarh, are the Mangeshpur drain and the Nangloi drain with a catchment area of 298 sq. miles. These two main drains have several small branches, which drain the countryside of Delhi. Besides these two main drains, there is the Najafgarh Jheel and its catchment, which also drains into the Najafgarh Nallah.

The beds of these drains have been heavily silted and choked up with the result that after a heavy rainfall, the water spreads out and submerges the surrounding crops. These drains have also very sharp bends.

A survey of the Najafgarh drain and the levels along the bed of the drain, has been carried out and this showed that the width of the Nallah had been considerably reduced due to silting up and a hump had been formed, which prevented the drainage from the Jheel side passing into the Yamuna. The work of the removal of the hump in the main Najafgarh drain as suggested by the C.W.P.C. has been completed by the C.P.W.D., with the exception of pitching, which also has been partly completed.

A survey is now in hand for improving the drainage of the Nangloi drain. The drain is proposed to be designed on the basis of a discharge of 5 cusecs per sq. mile in the catchment area. This is being done keeping in view the limited capacity of the main Najafgarh drain itself.

The survey of the Mangeshpur drain and its branches has not yet been undertaken.

Another drain, which serves to clear the storm water from the rest of the Alipur Block is the Bowana Escape drain, which discharges independently into the Yamuna. This drain has to be attended to also.

The rest of the problem of the rural Delhi relates to the villages between the Yamuna and the Shahdara Bund and the villages between the Yamuna and the G.T. Road below village Palla which are affected by floods from the river. In the first case the remedy is for these villages to be moved away. Sites have already been selected but the villagers have not moved so far. In the second case, that is in respect of the villages between the Yamuna and the G.T. Road, the remedy is for the sites of villages to be raised.

A bund in this region cannot be constructed as the Standing Yamuna Committee, which has been set up by the Ganga River Commission, has ruled that no long embankments on the River Yamuna are to be constructed by Delhi, U.P. or Punjab authorities. Such measures according to that Committee would cut out large valley storages resulting in higher flood levels at the Delhi Railway Bridge, thus endangering the safety of the bridge. Without any embankments the highest flood level already recorded at the Railway Bridge is upto the top of the piers. This scheme should give substantial relief to areas which are liable to flooding so as to minimise damage to crops at the same time ensuring that the water from the rural areas does not flow into the city but is properly drained off into the river. This has to be coupled with adequate flood protection measures against damage to village "abadies" in the event of heavy rains or floods in the river.

The Committee proposes to go into this matter further and to initiate or take suitable action in consultation with the Ministries concerned and irrigation authorities of the Uttar Pradesh and Punjab Governments.

ANNEXURE IV

According to the information collected so far, the following buildings and areas were affected by the recent floods:—

1. *Krishi Bhavan.*—Rain water accumulated on the Talkatora, Old Mill and Raisina Roads, rushed into this building and flooded its basements. The Executive Engineer in charge of the building who lives in the nearby Raisina Hostel, saw the invading waters, early in the morning. There were pumps fixed in the basement for pumping out rain water. These pumps were pumping out water upto 4 A.M. when sudden on-rush of water from outside submerged them. The filtered water tank and the pumping unit for the rain water also got submerged. Immediately pumps of the C.P.W.D. Fire Brigade were put in commission to pump out the flood waters. Another 20 pumps of various capacities were brought in and they worked non-stop for 48 hours and cleared all the basements and the grounds. No damage was caused to the structure any-where. Temporary arrangements were made for supply of electric energy and filtered water for the office. All accesses to the basements have been sealed by building small masonry walls across the six courtyards. An additional 6" dia. delivery pipe is going to be provided for the existing sump. The C.P.W.D. Fire Brigade pumps have been put on 24-hour duty. The submerged pumps are at present being repaired. Additional pumps have also been put on the ground near the sumps. There are two sumps into which rain water from the courts and the basement is collected by a system of covered drains provided for the purpose. The pumping units for rain water referred to above, pump the water from the sumps which consist of 4 electric pumps having an arrangements normal capacity of 60,000 gallons per hour which could, in an emergency, be augmented to 90,000 gallons per hour. The pumps are designed to pump rain water off the courts and the strip of land in the immediate vicinity of the plinth wall all round the building. On the morning of the 21st however, due to unprecedented rainfall accumulated water poured in from outside areas along the Talkatora Road, Old Mill Road, Raisina Road, etc., into the compound and the basement. The pumps were not expected to cope with this situation.

2. *Pandara Road Flats.*—Water got into a few quarters and stood about 3" deep on the floors. The colony was, however, got cleared of water in about 12 hours. No building sustained any damage.

3. *The D.G.S. & D. Hutments.*—About 40 rooms of these office hutments which were constructed to temporary specifications during the war and which have already long outlived their life developed cracks as a result of rain water, which accumulated there due to the incapacity of the underground drain (passing through the hutments area) to carry all the discharge contributed by the Shahjahan Road drains. The area was cleared after 12 hours. The underground drain is being cleared. The affected rooms are being vacated and repairs are being attended to.

4. *The All India Radio multi-storeyed building on the Parliament Street.*—The rain water, accumulated on the Parliament Street, found its way into the basement of this building through its ventilators. That water was pumped out quickly and the ventilators sealed off temporarily. No damage was caused. It is proposed to provide dwarf walls in front of the ventilators or to close the latter and then resort to artificial ventilation to make the basement useable.

According to the original plan, no basement had been provided. While the building was under construction it was found that subsoil under one wing was of a treacherous nature, which made a deeper foundation necessary. In order to make good use of the deeper foundations, a basement was provided in the wing. As the roof of that basement had to be kept at plinth level, which was not very much above the general ground level outside ventilators had to be provided at low level for necessary ventilation. During normal rains, there was no chance for the water to find entry into the basements through the ventilators. It was due to the piling up of water as a result of the very high intensity of shower that some quantity of water found its way through the ventilators down to the basements.

5. *Gandhi Sangrahalaya.*—A portion of the Compound wall fell down causing damage to the extent of Rs. 3,000/- approximately.

6. *City Extension area.*—A few houses on the Nurjahan Road, Press Road and Turkman Road stood in about 2' depth of water, but no damage was caused.

7. *G. O. I. Press Building.*—Water got into one of its godowns. No damage was caused to the buildings but some paper materials that lay on the floor were damaged.

8. *Fire Brigade Lane, Barakhamba Lane, Atul Grove Lane, Ferozeshah Road and Canning Lane.*—Rain water got into a few quarters in those places also, including the basement of the Connaught Place Telephone Exchange building. No damage, however, was caused to the building.

9. *King Edward Road, York Road and Sonehri Bagh Road areas.*—Road side drains in these areas had swollen to the maximum, but became clear by the evening of 21-7-58. The lawns of bungalows 5-Sonehri Bagh Road and 3 & 5 York Road, however, carried about 6" deep water for two days. Compound walls of those bungalows had to be broken by the servants of their tenants to provide quick passage to the trapped water. The buildings were not damaged by the rain water.

10. *Hastings Road, Ashoka Road & Akbar Road.*—Some of the very old servants quarters on those roads developed cracks *e.g.* those attached to 4 & 6 Hasting Road, 12 Akbar Road. They will have to be surveyed and possibly removed.

11. *Mansingh Road.*—The areas on this road including the compound of the Princely houses and the hutments attached thereto (Kotah House, Jaisalmer House, Dholpur House) were flooded. Whereas the temporary structures had 3" rain water standing over their floors, the main buildings were free from flooding. In the Dholpur House, pavement of a room sank-down as a result of this the partition walls standing thereon developed some cracks. This damage will be made good at a cost of about Rs. 1,500/-. In the Jaisalmer House, a temporary cycle shed collapsed and will have to be re-erected.

12. *C.B.R. Building and other buildings.*—The Nullah running by the side of Dr. Sen's Nursing Home in the Indraprastha Estate breached. According to unconfirmed reports the Nullah had been breached by the unauthorized squatters on the other side of the Nullah to prevent flooding on their side. The water gushing out of the breach spread over the whole area including the plot bearing the C.B.R. building. Due to continuous rainfall the level of this water rose to about 3'. On this account a few inches water stood on the floors of the C.B.R. building also. No damage to the building or any other property in the C.B.R. building occurred. The breach of the nullah has been closed. As a permanent measure the bund is being strengthened. There is also a proposal to replace the open drain by a covered barrel.

As a permanent arrangement it is proposed to instal pumps for pumping out the rain water, which will be collected in a sump by means of a drainage system, which is under construction. When the pumps are installed the drainage arrangement of this area will be adequate.

The flooding water surrounded the A.G.C.R. building also, but it did not get to its floors. The building was not damaged.

Minor damage was suffered by the stone pitching at the back of the Comptroller and Auditor General's Office Building.

13. 129 *acre plot on the south of the Hindustan Housing Factory.*—In two blocks, open paved platforms subsided. The contractor is making good this damage and the work is in progress.

14. *The 104 acres plot on the North of Medical Enclave.*—There was no accumulation of water here. The nullah embankment requires to be pitched as a precaution against the possible erosion in the future.

15. *The All India Medical Institute.*—Rain water entered the basement of the Preclinical Block through the opening in the basement below the Lecture Theatre, which has later on to be extended to the Teaching Block to be taken up in Phase II. All water was pumped out immediately. Some departmental electric stores however got wet. This damage is worth about Rs. 1000/- only. The opening has been sealed up now. No damage was caused to the structure. Electric energy to this block was interrupted for a day. The pumping unit that raised water to the overhead tank got affected but it was repaired and put into commission in 4 days time.

16. *The Zoological Park.*—This park spreads over about 200 acres of swampy land and does not, at present, command efficient system of drainage due to the presence of a Railway track behind it. The pavement level of the existing culvert No. 15 on the main railway line is too high and therefore cannot admit of efficient drainage of water. The result of this was that the low lying areas, pools, ponds and streams existing in the park area got flooded with rain water contributed by Purana Quila, Sundernagar and Sunder Nursery. The Structures as well as animals, including their enclosures were safe. The approaches to a few culverts however settled down to a certain extent Arrangements are proposed to be made for improving the drainage system of the park permanently.

17. *Delhi Mathura Road.*—The 27 feet high approach (Mathura side) to the recently built over-bridge (having maximum embankment height of 35 ft.) across the American warehouse railway line and the Delhi Mathura main railway line, settled down by about 1½' in a length of about 100 feet. The flowing rain water also scoured the embankment in a length of about 95'near one of the railway bridges. While the western carriageway was being repaired, the eastern one was opened to traffic within 24 hours. The total damage is estimated to cost about Rs. 5000/-. All bridges there are perfectly safe.

Two arch culverts—one in mile 9/1 and the other in 10/3 suffered damage on their downstream side. Both the culverts will be reconstructed after the Ministry of Transport gives their designs taking into consideration the recent heavy rains.

18. The Bund from Shah Alam Bridge to the Coronation pillar breached at three places—one near the escape channel from the Najafgarh drain and the other two near the sluices provided in the Bund for the drainage. All the three breaches have since been repaired by the C.P.W.D.

19. *The Rehabilitation Colonies.*—The drainage of all the Rehabilitation colonies was designed by the C.P.W.D. for a runoff of $\frac{1}{2}''$ per hour for the plains and $\frac{3}{4}''$ runoff per hour for the rocky areas like New Rajinder Nagar. Out of the 22 rehabilitation colonies, only five got flooded as explained below :—

(a) *Lajpat Nagar.*—An open drain passes through the colony and meets the Barapula Nalla. Across this Nalla, there are several road bridges besides one railway bridge. Due to the unprecedented rainfall, the nalla burst its banks, where the local residents had removed the earth area, and over flowed at several low-lying places. The Railway bridge will have to be widened and the two road bridges nearby remodelled.

(b) *Jangpura.*—The above mentioned nalla, passing through Lajpat Nagar also passes through Jangpura where it overflowed its banks specially at its junction with the Barapula nalla. The banks then will have to be raised with due regard to the flood levels during the recent heavy rains.

(c) *Nizamuddin.*—On the left bank of Barapula nalla there are three culverts which had been constructed long back presumably to drain away water of the Nizamuddin area into Barapula nalla when water in the latter is low. When water in the Barapula nalla is high, rain water of the colony cannot get therein. On the contrary the Barapula nalla discharges its contents into the colony. This is why Nizamuddin remained flooded for some time till water in Barapula nalla subsided. The only remedy for this will be to clear the bed and banks of the Barapula nalla to increase its efficiency and also to provide all the three culverts with gates which will have to be manually operated during the rains. It may be added that when the water in the Barapula nalla is high, rain water accumulated in this colony will have to wait till water in the nalla subsides. A solution appears to be in providing a permanent pumping plant there to deal with the rain water when level in the Barapula nalla cannot admit the drainage of the Nizamuddin area.

(d) *Sarai Rohilla.*—This colony got flooded with the water contributed by the high lying railway area. There is no proper outlet for this area. The drainage system of the colony will have to be reorganised by the Delhi Corporation.

(e) *Gandhi Nagar.*—This colony was developed beyond the left bank of the river Jumna where water gets impounded between the river embankment and the road. The drainage of this colony will be effected by pumping out rain water over the embankment into the river Jumna. The pumping units will be installed shortly. The Delhi Corporation are also looking into the problem of this colony.

Apart from the above a few roads and their katcha berms in the various colonies got damaged due to the rush of rain water. Also brick pitching in the same open drains slipped at several places in various colonies.

In old Delhi, the stone pitching of the Daryai Nalla (locally known as Ganda Nalla) slipped at several places The nalla over-flowed its banks in the section between Rohtak Road and the Railway line and flooded the area around causing damage to buildings there.

APPENDIX II

List of Emergent Repairs carried out

Sl. No.	Name of Nalla or Building affected	Locality	Nature of Damage	Repairs carried out
1	2	3	4	5
1.	Karbala Outfall Drain	Jorbagh	(*a*) Heavy silting in first 100 ft.	(*a*) Desilting completed.
2.	Kushak Nalla	Panchkuin Road to Jangpura	(*a*) Pitching damaged (*b*) Two breaches	(*a*) Pitching repaired. (*b*) Breaches closed.
3.	Lajpat Nagar Nalla	Lajpat Nagar and Jangpura	(*a*) Breaches in banks (*b*) Collapsing of mouths of inlets of storm water channels (*c*) Damage to brick pitching (*d*) Silting up at curves	(*a*) Breaches closed. (*b*) Repairs completed. (*c*) Repaired. (*d*) Desilting completed.
4.	Drains along Road passing through Exhibition Grounds	Purana Qilla and Stadium	(*a*) Damage to banks (*b*) Silting (*c*) Damage to pitching	(*a*) Repaired. (*b*) Desilting done. (*c*) Repaired.
5.	Storm-water drain in Indraprastha Estate (Drain No. 14)	Indraprastha Estate	(*a*) Breaches (*b*) Silting (*c*) Inadequate size of syphon to discharge water from level drain	(*a*) Repaired. (*b*) Desilting completed. (*c*) Syphon chamber widened.
6.	Daryala Nalla .	Rohtak Road and Sarai Rohilla	(*a*) Breaches (*b*) Damage to pitching	(*a*) Breaches repaired. (*b*) Pitching repaired.
7.	Najafgarh Drain .	Rehabilitation colonies in Old Delhi	(*a*) Damage to pitching along G. T. Road	(*a*) Pitching repaired.
8.	Friends' Colony Drain	Friends' Colony	(*a*) Damage to pitching (*b*) Breaches on sides	(*a*) Repaired. (*b*) Repaired.
9.	Chirag Delhi Nala	Defence Colony	(*a*) Minor breaches	(*a*) Breaches repaired.
10.	Krishi Bhavan	Queen Victoria Road	(*a*) Flooding of basement	(*a*) Entries to basement sealed off.
11.	All-India Radio Building	Parliament Street	(*a*) Flooding of basement	(*a*) Entries to basement sealed off.
12.	All-India Medical Institute	Medical Enclave	(*a*) Flooding of basement	(*a*) Entries to basement sealed off.
13.	Delhi Mathura Road Railway crossing	Bhogal	(*a*) Approach settled down by 1½ ft. in a length of about 100 ft.	(*a*) Repaired.
14.	Bund from Shah Alam Bridge to Coronation Pillar	Old Delhi	(*a*) Breaches at 3 places	(*a*) Repaired.

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APPENDIX III

REPORT ON STORM WATER DRAINAGE BLOCK—1 BY CENTRAL PUBLIC WORKS DEPARTMENT

1. Introduction

1.1 Flooding, damage to property and dislocation of civic services as a result of the rainfall of July 1958 brought out clearly the inadequacy of the drainage system of Delhi area. For purpose of drainage the Delhi area could broadly be divided into 4 major catchments :—

(1) The Catchment of the Barapulla Nalla,

(2) The Catchment of the Najafgarh Drain,

(3) The Catchment of the City Ditch, and

(4) Shahdara Area.

The catchment of the Barapulla Nalla covers New Delhi area and extends on the south as far as the Air Firing Range at Tilpath. The Najaf Garh catchment mainly drains the rural areas in West and North of Delhi. The City ditch drains the Delhi City area.

Refer to plan No. 1·1 for the 4 different catchments.

1.2 The New Delhi area forms the most important part and the Barapulla catchment. A survey of the drainage system of the New Delhi area was made by the Central P.W.D. while exploring the means of lowering the subsoil water table. In respect of the Najaf Garh Catchment the Central Water & Power Commission is already seized with the problem of drainage of rural areas. As regards Delhi city and Shahdara the Corporation has the necessary data to proceed with investigations.

1.3 The Committee for prevention of floods and other calamities therefore directed that investigation on the drainage of Block I should be undertaken by the C.P.W.D. while the C.W.P.C. could take up the investigation of Block 2. The Corporation was entrusted with the task of investigating the drainage systems in Blocks 3 & 4.

1 4 This preliminary report deals with the investigations carried out by the C.P.W.D. in Block 1. The report indicates the lines on which investigations were carried out to locate the deficiencies in the existing drainage system of this catchment It also details out the improvements to the existing drainage arrangement, considered necessary.

2. Description of Block I

2.1 Block 1 comprises an area of 40,700 acres. The natural limit of the area on the west is the ridge and on the east the river Jumna. The area extends upto the Air Firing Range at Tilpat on the south and its northern boundary extends upto Panchkuin Road and Circular Road. The extent of the catchment is indicated in Plan 2·1. The entire stormwater of this catchment area drains into Jumna. The main outfall channels are the Barapulla Nalla, the Friends Colony Nalla, the Sunder Nagar Drain, the Exhibition Nalla and the nalla through the Indraprasta Estate. Of these, the largest and by far the most important is the Barapulla Nalla with a catchment of 34,400 acres. This nalla in its upper reaches is called the Kushak Nalla, and from the point of its confluence with Sonehripul Nalla is called the Barapulla Nalla. The catchment of the Barapulla Nalla covers practically the entire Block 1 excluding Friends Colony and a few other areas which are independently drained by other minor nallas. The catchment of the different nallas are also shown in Plan No. 2·1.

2.2 On the basis of drainage characteristics, the catchment of the Barapulla Nalla could be broadly divided into 3 distinct areas :—

	Acres
(*a*) Built up areas (including areas likely to be built as per Interim Master Plan of the T. P. O.	15,400
(*b*) Unbuilt areas	9,000
(*c*) Rural areas	10,000

2.3 *Built-up areas.*—This area consists of New Delhi as it existed prior to 1939 and also the colonies on the south that were developed since then. The drainage system of this area consists of primary drains in the form of surface pitched drains emptying into covered barrels. These barrels discharge into outfall nallas which join the river Jumna at suitable places. The drainage system of most of the area built prior to 1939 was designed on the basis of a ½" run off while areas developed after 1939 are on the basis of ½" to 1" run off.

2 4 *Unbuilt and rural areas.*—These areas are mostly to the south of the Capital and are drained by the Chiragh Delhi nalla which joins Kushak nalla near Defence Colony. This area has a fairly good slope, and is rocky in small portions. Much of it is cultivated land. Due to the good slope there is hardly any complaint of flooding in this area.

3. Areas flooded and causes

3.1 The major complaint of flooding in Block 1 as a result of rainfall of 20th and 21st July, 1958 was:—

(a) From low lying areas, like Gole Market, Fire Brigade lane, Parliament Street, Parts of Ashoka Road, Talkatora Road, Old Mill Road, Raisina Road, Queen Victoria Road, York Road, King Edward Road, Central Vista, Golf Link area and Jor Bagh.

(b) From places where open nallas over flowed the banks affecting parts of Lajpat Nagar, Jang Pura, Indraprastha Estate and Friends Colony.

(c) From areas which could not drain on account of high water level in the outfall nallas, like Nizamuddin.

3.2 This flooding was the result of poor interception, inadequate capacity of the existing drains and unsatisfactory conditions of flow obtaining in the outfall channels.

3.3 *Interception.*—The preliminary survey indicated that the number of inlet gratings along the roads is inadequate. Interception arrangement at the roundabouts is also poor. Levels and gradients of lawns and berms are not sufficient to ensure quick flow of rain water into the drains. The lawns were originally made saucer-shaped to conserve rain water.

3.4 *Inadequacy of the main drains.*—In 1913, the Delhi Town Planning Committee had recommended that the stormwater drainage system for the Capital should be designed for ½" run off from the built up areas and 1" from the ridge area. Though no reason could be traced for not following these recommendations it is observed from the estimates for the stormwater drainage prepared in 1918 that the system was actually designed for a run off of ¼" for built up areas excepting the Secretariat buildings and the then Viceregal Estate for which 1" run off was adopted. It would have been an ideal condition if the drainage system was so designed that there would have been no tide locking of the drains when the river was in floods. The report of the 1918 estimates however, states that to obtain such a condition the working velocities in the pipes would be very much less and consequently the cost of the project would be very much more. Backing of the river water into the pipes and consequent silting was therefore accepted as a necessary evil for which the remedy suggested was occasional flushing from irrigation or domestic water supply.

3.5 This drainage system as originally laid in 1918 underwent little modification except that due to the extension of the city the outfall channel No. 3 was covered and converted into barrel upto the point where it meets Sonehripul Nalla. Plan No. 3-1 indicates the drainage system as it exists to-day.

3.6 The New Delhi Development Committee in 1939 have in their report stated that except for occasional flooding under the Minto Road Bridge and the Hardinge Bridge the stormwater drainage system was functioning satisfactorily. From the occasional floods then reported we have now frequent complaints of flooding in areas, like Market Square, Minto Road Quarters, Fire Brigade area etc., and also stagnation of water in roundabouts and backing up of water in the various outfall channels. Perhaps, inconvenience due to flooding was not felt in those days as Simla was the seat of Government during Summer monsoon periods.

3.7 The basis of the original design had, therefore, to be reviewed. It is now proposed that the drainage system should be remodelled for a run off based on the rational method of design for stormwater drains and not on any *ad hoc* basis. The rational method recognises the relation between the rainfall and run off. Under this method it is necessary to determine first the time of concentration which is the length of time required to establish run off and for the water to flow from the most distant point of the area to the inlet and thence from the drains to the point under consideration. Secondly the intensity of rainfall corresponding to this period of time should be determined. Also it would not be economical to design a stormwater drainage system for the worst anticipated rainfall. On the basis of study of rainfall data, the main Committee has decided that it would be sufficient if the drainage system is remodelled for a storm likely to occur once in 2 years. The time of concentration for the main drains would be one hour while for the branch drains it would be 30 minutes. The corresponding intensities of rainfall of frequency once in 2 years for these times of concentration would be 1·65" and 2·5" per hour. Applying the appropriate co-efficient of run off for the New Delhi area the actual run off for which the main drainage system is to be remodelled works out to 0·5" per hour and 0·75" per hour in the case of branch drains. This has been the guiding principle in suggesting suitable measures for improving the capacity of drainage system of built up areas in Block 1. In this connection refer to minutes of the meeting of the Technical Sub-Committee, held on 16-8-1958.

3.8 The original designs do not indicate the exact run off taken for the rural and unbuilt areas for purpose of design of the nallas. For purpose of remodelling the existing drainage system a run off of 10 cusecs per square mile has been taken for rural areas while for the unbuilt areas a run off factor of 0·2 has been taken. In this connection refer to the minutes of the meeting of the Technical Sub-Committee, held on 4th November, 1958 and 27th November, 1958.

4. Description of the drainage system

4.1 *Internal drains.*—As already mentioned in para 3·4 the drainage of the New Delhi area built prior to 1939 was for of 1/4" run off while the new colonies that were built since then are for 1/2" to 1" run off. On the basis of rational method of design for the stormwater drainage as discussed in para 3·7 it is seen that only stormwater drainage system of New Delhi area built prior to 1939 requires remodelling in respect of the internal drains. The internal drainage system of the new colonies gave no cause for trouble and where flooding did occur it was a result of unsatisfactory outfall conditions. Therefore, for purpose of detailed investigations it is only the internal drainage system of the New Delhi area built prior to 1939 that required examination.

4.2 The stormwater drainage system of the New Delhi area prior to 1939 as shown in Plan 3·1 consists of 16 main drainage lines. Description of the area covered by each is as follows:

4.3 *System* : (*Kushak Nalla*).—The first system although it is called the Kushak Nalla is not the original Kushak Nalla but an artificially dug channel pitched with bricks or stone in its head reach. It starts from Punchkuin area, runs along the toe of the Delhi Rock Ridge, crosses the Kitchner Road, passing near the Race Course Road, it crosses the Railway Line, crosses Qutab Road and joins the Barapulla Nalla which has its outfall into the Jumna River. Although this drain takes very little run off from the New Delhi area it is important because it takes away the entire run off from the Delhi Ridge which otherwise would have entered and flooded the level parts of New Delhi.

4.4 *System 2.* (*Drain 3-C*).—This drainage line starts from Kitchner Road travels southwards till it reaches a point near Safdarjang. Then it turns north-east and running along Aurangzeb Road it joins drain '3' system 4.

4.5 *System 3.* (*Drain 3-B*).—It starts from Safdarjang Road travels along Prithviraj Road and joins system No. 2 at the junction of Albuquerque Road and Aurangzeb Road.

4.6 *System 4.* (*Drain 3*).—It starts from a point west of South Avenue, then it runs along Dalhousie Road, Hastings Road, Albuquerque Road and Aurangzeb Road and ends in the Cemetry Chamber near point 'Q'.

4.7 *System 5.* (*Drain 3-D*).—Its starting point is near South Block of Secretariat. It travels along King Edward Road and York Road and joins point 'Q'.

4.8 *System 6.* (*Drain 1-D*).—This system of covered drain with its open surface laterals starts from the junction of the Reading Road and Park Street. It runs along Talkatora Road and joins system 7 at the junction of Talkatora Road and Parliament Street.

4.9 *System 7.* (*Drain 1-E*).—Starts at North Avenue runs along Church Road, Queen Victoria Road, Man Singh Road and drops at 'Q' point.

4.10 *System 8.* (*Drain 1-C*).—Starts from the junction of Reading Road and Havelock Road, runs along Havelock Road and Ashoka Road and joins system No. 9 at the junction of Ashoka Road and Queen Victoria Road.

4.11 *System 9.* (*Drain 1*).—This system has its source at the junction of Punchkuin Road and Reading Road. It runs along Punchkuin Road passes through Connaught Place and Curzon Road and joins 'Q' point.

4.12 *System 10.* (*Drain 1-A*).—Starts at the junction of Reading Road and Albert Road, turns along Lady Harding Road and joins System No. 9 at Janpath.

4.13 *System 11.* (*Drain 1-B*).—From the junction of Reading Road and Presbyterian Road, runs along Presbyterian Road and Market Road and joins system No. 8.

4.14 *System 12.* (*Drain 5*).—Starting from India Gate this drain runs along Purana Quila Road, crosses Railway culvert No. 14 near the Zoo and then falls into the Jumna river. From India Gate to its junction with the Delhi Mathura Road it is a covered drain after which it becomes an open nalla.

4.15 *System 13.* (*Drain 6*).—This system starts from north of Connaught Place near Chelmsford Road, crossing the Railway line near the Electric Sub-station, it runs along Rouse Avenue till it meets Hardinge Bridge. At this point it becomes an open nalla which goes and joins the river.

4.16 *System 14.* (*Drain 2*).—It starts from Connaught Place, goes along Barakhamba Road, Sikandra Road and crosses the Railway line.

4.17 *System 15.* (*Drain 4*).—This drain comes from Paharganj, runs along Rouse Avenue, goes upto Hardinge Bridge and joins System No. 13.

4.18 *System 16.* (*Drain 7*).—This system of drains starts from the junction of Circular Road and Minto Road. It travels along Circular Road and falls into the river near Delhi Gate Power House.

4.19 A summary of the observations by the Executive Engineer, Sub-soil Water Division on the working of the internal drainage system of the New Delhi as a result of survey during monsoon months of 1955 to 1958 is reproduced below :—

4.20 "The drainage system of New Delhi was checked for 1/4" run off from the catchments of various main drains. Even for this run off the following sections are found to be inadequate.

4.21 Stormwater drain which runs along Curzon Road and finally drops into the sump at 'Q' point is undersized. It should be able to take 367 cusecs against its present capacity of 307 cusecs. This is the cause of flooding behind the Constitution House. (System 9).

4.22 The drain on Talkatora Road is slightly undersized, just before its junction with the other drain near Parliament House. At this point it has a capacity of 63·5 cusecs. It should be able to take 7 cusecs of discharge more. (System 6).

4.23 Stormwater drain along the Barakhamba Road is wholly inadequate in its reach from Connaught Place to Mandi House. It should cater for nearly 30 cusecs of discharge more. At present it has a capacity of 42 cusecs only. Because of the inadequate capacity of this drain water stagnates near the Fire Brigade area. As an emergent measure it is suggested that a relief drain starting from the Fire Brigade and leading to the drain No. 6, which is lightly loaded, should be constructed before the next monsoon. (System 14).

4.24 The drain along Aurangzeb Road is capable of taking only 230 cusecs. It should carry 55 cusecs more in its last reaches. Other drains of the same system along Prithvi Raj Road and York Road are also undersized."

4.25 It is thus seen that portions of the internal drainage system of the New Delhi area built prior to 1939 is inadequate even for a 1/4" run off.

4.26 *Outfall Channel No. 3.*—The stormwater drainage system of the major part of New Delhi area discharges into 'Q' point. (Refer to Plan 3·1). From (Q) point stormwater is taken to a sump behind Cemetry. From here the entire stormwater is taken by means of a covered conduit and joins Sonehripul Nalla at the crossing of the Lodi Road.

4.27 On the basis of 1/4" run off the total quantity of stormwater that comes to 'Q' point is 750 cusecs but the covered Elliptical Barrel of the outfall Channel No. 3 between 'Q' point and the Khan Market has a capacity of only 563 cusecs when running 3/4th full. But the trapezoidal covered conduit beyond the Khan Market upto the Sonehripul outfall has however a capacity of 933 cusecs. It is, therefore, seen that even for a 1/4" run off a section of the covered outfall Channel is inadequate.

4.28 *Sonehripul Nalla.*—This nalla takes off from the outfall Channel No. 3 near the Lodi Road and finally falls into the Barapulla Nalla. Its bed width at the start is about 80' and for a length of 1000' in its initial reaches has no defined banks. Further downstream however, the nalla has well defined banks and the bed width of the nalla where it meets the Barapulla Nalla is about 160 Section of the nalla is adequate to take discharge on the basis of 1/4" run off but however, due to the conditions of flow obtaining in Barapulla Nalla and Kushak Nalla there is heading up of water in this nalla during peak periods of flow in the main drains. The conditions are worse when the river is in floods.

4.29 *Barapulla Nalla.*—The Sonehripul Nalla joins the Barapulla Nalla somewhere near Jangpura. After crossing the Mathura Road and the Ring Road it finally joins the river Jumna. The nalla has a well defined section with a bed width of 210 feet at the start widening to about 300 feet at the Barapulla Bridge. Beyond the Barapulla Bridge however, the nalla has no banks and during the monsoon and when Jumna is in floods the entire low-lying area beyond Barapulla Bridge gets flooded.

4.30 The above review establishes the inadequacy of the existing drainage system.

5. Sample Surveys

5.1 Finding out all deficiencies and preparing schemes for improving the drainage system of this catchment will take at least 6 months. The Main Committee are desirous of submitting their final report to the Government on terms of reference by the end of December. As it is not possible to complete all the investigations and suggest suitable remedial measures within this brief period this report with costs has been prepared on the basis of sample survey conducted during the last 2 months. Sample surveys were conducted on :

(*a*) the interception arrangement and adequacy of main drain No. 1-C from Reading Road upto Q point,

(*b*) capacity of the outfall Channel No. 3 from Q point, upto Sonehripul Nalla,

(*c*) improvement of drainage of local areas, such as Jor Bagh and Golf Link Colonies,

(*d*) Improvement to the Barapulla Nalla to enable it to take a higher run off,

(*e*) Relief measures necessary for improving the drainage of low lying areas, such as Market Road Quarters, Fire Brigade Lane and Minto Road area, and

(*f*) Regrading of Kushak Nalla.

On the basis of these investigations the probable cost of the improvement of the entire drainage system of Block No. 1 has been worked out and is given in Appendix VIII. Although sample investigations have been confined to the Barapulla catchment *ad hoc* rates have been derived and applied to entire Block 1 for the preparation of this project estimate.

5.2 *Interception arrangement and adequacy of Main Drain.*—For purpose of sample survey Drain 1-C has been taken to represent the internal drainage system of pre 1939 New Delhi. It starts from the junction of the Havelock Road and Reading Road. It runs along the northern berm of the Havelock Road upto the Gole Post Office. From this point it is taken along the southern berm of the Ashoka Road upto R point. Please refer to Plan No. 3·1 which indicates the alignment of this drain. At this junction it joins Main Drain No. 1 coming from the Curzon Road end. This main drain runs along the eastern berm of Man Singh Road upto Q point. The total catchment of the drain No. 1-C up to R point is 604·39 acres. Previous investigations revealed that this drain has an adequate capacity upto R point to take 1/4" run off. Apart from the adequacy of the drain investigations were also carried out to find out if the present interception arrangement was satisfactory.

5.3 *Interception of Storm water.*—All along the alignment of this drain 1-C it is observed that a Pakka pitched drain exists only on one side of the road. On the other side there is a Kacha drain over the underground barrel. Every 250 feet there is a gully grating and the stormwater from the berms and half the portion of the road enters the covered barrel through the gully gratings placed just over it. The stormwater from the compounds from this side of the road has an entry into covered barrel the same way.

This system of interception is unsatisfactory. Flow in the Kacha drain is slow and could be improved by pitching it. It is now proposed to convert these Kacha drains into pucca ones of size 12"×18" and connect it to the covered barrel at their ends.

The details of work required to improve the interception section-wise is indicated below :

5.4 *Havelock Road.*—The road has a longitudinal gradient of 1:125 towards the Gole Post Office. The cross slope is 1 in 48.

To drain the road surface, gully gratings at 250' apart are provided on the northern edge. For an efficient interception of storm water running along the Kerb Channel the gratings should be placed at closer intervals of about 120 feet (Reference Storm Water drainage by Escritt, Page 347). Additional gully gratings will have to be provided to improve the interception along this alignment.

5.5 On the southern edge 4" dia. stoneware pipes placed at right angles to the Kerb line and spaced 800' apart take water from road surface to the road side drain. These link pipes are mostly choked. On account of their orientation they do not intercept the stormwater flowing along channels effectively.

5.6 It is therefore, proposed to provide gully gratings 18"×20" size spaced 125 ft. apart all along the southern edge of the road. The link pipes will join the covered barrel as shown on plan 5·1 and at cross section A.B.

5.7 *Ashoka Road.*—Surface camber of the road is 1 in 57. Along its edge from Gole Post Office to its junction with Parliament Street there are only 4 gully gratings in a length of 2000'. Beyond this and upto R point there are neither gratings nor link pipes to conduct storm water to the road side drains.

5.8 To intercept the road surface water it is necessary to provide gully gratings spaced 125/apart all along the edge of the road. The gratings could be connected to the road side drains. Only where invert levels of the road side drain do not permit of such connections it is proposed to provide 6" dia. R.C.C. link pipe to drain away water from the Kerb Channel. Though from discharge point of view 4" dia. pipe would be sufficient, a 6" dia. R.C.C. pipe is proposed for easy maintenance. A chamber on the link pipe would facilitate proper maintenance.

5.9 *Man Singh Road.*—The surface camber is 1 in. 40. This is satisfactory.

On both the edges of the road, gully gratings are spaced about 250' apart For better interception it is proposed to have gully gratings 125 apart on both the edges of the road.

5.10 *Interception near roundabouts.*—The interception arrangement near the roundabout is far from satisfactory. The flooding of roads at the round-abouts is common experience even in rains of normal intensity. Many of the roads slope towards the roundabouts and if the storm water coming along the roads is not intercepted properly there is bound to be flooding at the round-abouts. It is expected that with the improved interception all along the roads there will be little flow along the roads. The remaining flow of storm water along the roads require proper interception at the round-abouts.

5.11 The main defects in the existing arrangement are :—

(1) Inadequate number of gully gratings at these round-abouts.

(2) Wrong positioning of the existing gully gratings.

Detailed study of the existing interception arrangement at round-about near Krishi Bhawan has been made. Proposals for improving the interception arrangements have also been formulated. On the basis of this study provision has been made in the project estimate for improving the drainage arrangement at the 7 round-abouts along the alignment of this drain.

5.12 *Remodelling of the Drainage system.*—As already mentioned, the main drains, like I-C are to be re-designed for 1/2' run off from their catchments. Laterals and branch drains feeding the main drain should, however, be remodelled for 3/4" run off because the time of concentration required to establish run off in them will be 39 minutes as against 60 minutes in the case of main drains.

5.13 The drainage system 1-C consists of lateral open surface pitched drains, branch drains along service roads and road side drains open or covered. This is shown on plan 3·1.

5.14 *Laterals.*—The lateral surface drain A.B.C.D. shown on plan 5 has a section of 10″×13″ and has a catchment area of 2·2 acres. It has a slope of 1 in 542. It has a capacity of 4·7 cusecs while running 10″ deep. This is adequate to take 3/4″ run off from its catchment. It needs no remodelling.

5.15 *Branch Drains.*—The branch drain on Maude Road in a length of 785 feet from point X to point Y has a section of 16″×21″ and bed slope of 1 in 900. It has a capacity of 10·86 cusecs while running 15″ deep. It can therefore take 3/4″ run off from its catchment area of 10·1 acres. In this reach it needs no remodelling.

5.16 The same branch drain from point Y to point Z has a section of 16″21″ bed slope of 1 in 1000 and capacity of 10·3 cusecs. At point Z, it has a catchment of 25 acres. On the basis of ¾″ run off it must take 18·75 cusecs. Thus the branch drain requires remodelling in this reach.

5.17 It will be seen from the section at point Z shown on plan 5·2 that if the bed width is increased by 2′—2″ without changing the bed level the H.F.L. will be R.L. 717·50 *i.e.*, 6″ higher than the existing H.F.L. 717·00. However the plot level here is R.L. 719·77. Therefore increase in H.F.L. by 6″ would not matter. A section of 3′—6″×1′—9″ is therefore proposed for this section. Other branch drains will require similar resectioning so that they may be able to take ¾″ run off from their catchments.

5.18 Road side drain on Havelock Road has a section of 9″×16″ and bed slope of 1 in 250. Its catchment area is 31 acres. Present capacity of the drain at point L is 4·1 cusecs. If this section is to take ¾″ run off it should be remodelled to 3′—9″×1′—4″ with the same H.F.L. 719·57. Here the plot level is 719·57. Road side drains on other main drains will require similar remodelling.

5.19 *Covered Barrels.*—Covered barrel of drain No. 1-C starts with a section of 24″ dia. on Havelock Road. It runs along Ashoka Road and just before joining main drain No. 1 at R point it has a section of 84″ dia. The existing covered barrel is designed for 1/4″ run off. If its capacity is to be augmented for 1/2″ run off, keeping the same bed slopes and invert levels as those of the existing drains, duplicate barrel will have to be constructed or the existing barrel will have to be remodelled.

5.20 It will be more economical to run a duplicate line to carry this additional discharge than remodelling the existing line. Further it is not possible to interfere with the existing drainage arrangements during the periods of monsoon. The only difficulty in constructing a duplicate drain would be to find sufficient space in the berms of roads. Existing service lines like sewers, water mains, electric or telephone cables leave little space for any additional service line. Therefore positioning of the duplicate line presents difficulty and has to be done after careful study of the existing services and trees along roads. The proposals for duplicating the covered barrel along this alignment is discussed below:

5.21. *Duplicate line on Havelock Road.*—The existing barrel on northern berm of Havelock road is 24″ dia. It can take 13·20 cusecs while running 3/4th full. The total catchment of this drain in this reach is 62·21 acres. The total run off on ½″ basis will be 31·11 cusecs. The duplicate barrel will therefore have to take an additional discharge of 17·91 cusecs. For this a barrel of 27″ dia. will be necessary as shown in table 1. This could be laid on Southern berm. The proposal is shown in cross section in plan 5·1. The duplicate line will be sufficiently away from the tree line and the road side drain. It will not cross water mains or sewers or cables. A complete plan showing cable layouts could not be obtained from N.D.M.C. but is understood that all main cables are laid 4′ from the edge of the road and not more than 4′ deep. Position of branch cables is not known at the present, but if required these may not be difficult to shift.

5.22 *Duplicate line on the southern berm of Ashoka Road.*—The existing barrel runs on the southern berm of Ashoka Road. The proposed additional barrel is shown in cross section A.B. on plan 5·3.

The duplicate barrel can be accommodated, as shown on the plan, first by the side of the existing drain. The alignment of the existing barrel is not truly parallel to centre line of the road. The duplicate line therefore runs into the existing ones. At such places chambers are provided. These will help in equalising the flow through the existing as well as duplicate barrel in different reaches. For the capacities of the proposed and existing drains please refer to table 1.

5.23 *Duplicating the line on Man Singh Road.*—Man Singh Road starts from R point and terminates at Q point. On the eastern berm of the road runs the 102″ dia. barrel called drain No. 1 and on the western berm runs the 96″ dia. barrel called drain 1-E. This is shown in cross section LC plan 5·4. All the roads have only one covered barrel along their alignment but along this road there are two large covered barrels (One on each berm) giving very little space for laying any additional service line.

5.24. At present drain 1-C meets drain 1 at this R point. Before the junction of drain 1-C with 1, drain 1 has a capacity of 307 cusecs. For ½″ run off capacity of drain 1 before its junction with 1-C will have to be increased to 729 cusecs. Drain 1-E along the same road has a capacity of 269 cusecs while on the basis of ½″ run off it is required to carry only 197 cusecs. It has therefore a reserve capacity of 72 cusecs. As the additional drain along drain 1 will have to carry 422 cusecs, it will not be possible to discharge 302·2 cusecs from drain 1-C into this drain without making it unduly large.

Site conditions do not permit the construction of such a large drain and it is therefore proposed to divert the entire flow of 302 cusecs from the existing and proposed barrel along I-C into duplicate drain I-E. The new barrel along I-E will carry all this 302 cusecs in addition to 125 cusecs as a result of ½″ run off from its own catchment beyond the point where it meets drain I-C. For this purpose two covered rectangular conduits 8′1 × 1′ in size have been proposed ; one will run parallel to I-C while the other will run parallel to I-E.

5.25 Hydraulically a circular barrel section is most efficient. Next to it is the horseshoe section. Both types of sections with restricted height of 8′-6″ and fixed bed slope of 1 in 1300 as in this case will not have adequate capacity, hence in this reach a rectangular conduit is proposed even though this is more expensive. This type of section will be required only on Mansingh Road for augmenting drains No. 1, I-E and I-C. This difficulty will not be there for other main drains. Hence cost for remodelling for this section has to be accounted for separately.

5.26 Summing up the improvements to the existing drainage arrangement along this alignment would take the following forms :—

(*a*) Converting the existing Kacha drains on one side of the road into a Pakka pitched drains.

(*b*) Increasing the number of gully grantings all along the road.

(*c*) Increasing the size of the outlet pipes from 4 inches to 6 inches.

(*d*) Regrading the berms wherever necessary.

(*e*) Improving the interception arrangement near round abouts by increasing the area of gully grantings and using combination grantings with vertical and horizontal openings.

(*f*) Increasing the capacity of the existing drains wherever called for by laying duplicate lines.

5.27 Based on this sample survey the cost of remodelling the internal drainage system of pre 1939 New Delhi has been worked out. The total expenditure likely to be incurred will be Rs. 1·6 crores. For details *see* annexure 1.

5.28 *Augmentation of the capacity of outfall Channel No.* 3.—The storm water drainage system of the major part of New Delhi discharges into Q point.

5.29 Drains 1 & 1E coming along Mansingh Road and drain No 3D along York Road discharge into Q point. From Q point storm water is taken out by three barrels and it is collected into a chamber behind cemetry. Drain No. 3 along Aurangzeb Road also joins this chamber direct. The combined discharge of 1, 1E, 3D, 3 is then taken by a covered elliptical barrel for a distance of 1750′ (from cemetry to Khan Market) and afterwards the section changes into a trapezoidal one. Trapezoidal conduit has outfall into Sunehripul Nallah.

5.30 Q point sump is accessible from the cemetry chamber. On inspection of Q point it was observed that Q point itself acts as a syphon and no syphonic arrangements exist beyond Q point. It appears that the syphonic arrangement at Q point was necessitated because of sewer line along Shahjahan Road which crosses the drainage lines at this point.

5.31 Three barrels between Q point and cemetry chamber have been inspected and it has been found that the central barrel has been silted upto an extent of 1′ to 2′. The plaster has also flaked off in patches and a small quantity of subsoil water finds its way into these barrels. It was seen at the time of inspection of Q point that storm water drain 3D was flowing about 1′ deep although it was dry weather. On further detailed inspection it was found that subsoil water was finding its way into the barrel.

5.32 *Cemetry Chamber.*—This is a rectangular structure slabbed over by an R.C.C. slab into which 3 barrels coming from Q point and No. 3 drain discharge. Overflow from the trunk sewer also enters this chamber. There is about 1′ to 2′ of silt in portions of this chamber. As decided by the sub-committee the baffle wall in the cemetry chamber has been dismantled. Except for flaking of plaster of the R.C.C. roof in many places, the condition of the chamber appears to be satisfactory.

5.33 In the reach between cemetry and Khan Market the out fall channel has an elliptical cross-section with a maximum width of 18′ and maximum depth of 10′. The slope of this drain works out to 1 in 4000.

5.34 Beyond Khan Market the channel has a trapezoidal cross-section. This has maximum width of 25′ at springing point and has a bed slope of 1:2500. A small cunette has been provided in the centre for small flow. However, there is always 2′ to 3′ of water in this section because of the sewage overflow backing from Sunehripul Nallah.

5.35 *Discharge Calculations.*—The discharge on the basis of ¼″ run off which is expected to be drained into Q point works out to about 1066 cusecs. With remodelling of entire New Delhi storm water drainage for a run off of ½″ this discharge is expected to increase to 1800 cusecs. Covered elliptical barrel has a discharge capacity of 563 cusecs when running ¾ the full and the trapezoidal channel has a capacity of only 933 cusecs. The existing section of the outfall channel will be wholly inadequate to handle discharge of 1800 cusecs. Apart from this inadequate capacity the outfall channel will be tide locked when Kushak Nallah is in spate. Investigations were carried out on the lines indicated below for remodelling the outfall channel No. 3.

1. By augmenting the capacity by laying additional channels.
2. By diverting some drains which are at present discharging into Q point into other suitable outfall channels.

5.36 As mentioned in para 5·34 a portion of the outfall channel is inadequate even to carry ¼″ run off. Therefore, the capacity of the existing drain in this reach required augmentation by providing the additional drain of adequate capacity not only to cater for the present deficiency on the basis of ¼″ run off but also for the additional run off expected when the capacity of the branch drains is augmented. Between the Cemetry Chamber and Khan Market there is no space for an additional channel along the alignment of the existing barrel. However, spaces can be found for the additional drain between Khan Market and Lodi Road. It is, therefore, proposed that additional barrel in the reach between Cemetry Chamber and Khan Market could be taken along the Hamayun Road and Cornwalis Road. This barrel will meet the existing one near the Khan Market. Necessary surveys for these have been carried out and no obstacles are foreseen in carrying out the above proposal.

5.37 The additional channel between the Q point and Khan Market has been designed for a capacity of 1237 cusecs and additional channel between the Khan Market and Lodi Road has been designed for capacity of 867 cusecs when running ¾th full. Near the Khan Market a chamber will be necessary to properly divert the flow of the channels from the upper reaches into the channels in the lower reaches. The normal depth of flow in the channels will be 7′-6″.

5.38 Increasing the capacity of the outfall channel alone may not give all the desired relief as the outfall conditions are unfavourable. Under the existing conditions of flow the maximum water level at the Sonehripul Nallah at this point will be 673·6. With the proposed improvements to the Nallah the level will be brought down to 671·2. The level in the outfall channel at this junction will be 671·06. As the maximum water level in the Sonehripul Nallah will be 671·2 there will be a slight back flow but it has been verified that this minor heading up will not affect efficiency of the outfall channel.

5.39 The total cost of laying the additional channels is estimated at Rs. 27,10,000 excluding Departmental Charges. Details of the cost and the plan Nos. 5·7 showing the proposals are shown as annexures of this report.

5.40. The preliminary investigations reveal that there is no possibility of diverting any of the existing drainage lines to other outfall nallahs. The entire area has a slope towards the Q point and as the other minor nallahs are already tide locked during floods in the river it will not be possible to divert any of the covered barrels away from the Q Point.

5.41 *Improvement to the drainage of Jor Bagh Area.*—The internal drainage system of Jor Bagh was designed for an *ad hoc* run off of 1″ per hour. On the basis of rational method of design for storm water drainage the run off for this area works out to the same figure of 1″ per hour.

5.42 The Northern half of Jor Bagh drains into the drain along Lodi Road which joins the Sunehripul Nallah. The Southern half drains into the drain along Jor Bagh Road which discharges into the Karbala Nallah. The flow conditions in these two drains are dealt with separately below. Plan No. 5.8 shows the drainage arrangements.

5.43 *Lodi Road Drain.*—This is an open brick pitched drain. It starts from the crossing of Tughlak Road and Lodi Road. Its invert level at the start is 682.90 and it has a slope of 1 in 1350. With its existing section its capacity in the reach where it leaves Jor Bagh is 42 cusecs for a depth of flow of 2′-9″. The discharge into this drain from the Jor Bagh area for 1″ run off is 24 cusecs. The only other area draining into the Drain in this reach is 15 acres from the Lodi Estate from which the run off will be not more than 15 cusecs. It will thus be seen that the capacity of the drain is sufficient to take the discharge when running to a depth of 2′-9″. Under this condition the water level in the drain is 685·65 at the start and 684·01 at the point where it leaves Jor Bagh. The reduced level of the lowest point discharging into this drain is 687.

5.44 Some of the culverts across this drain have however insufficient water way. There are 5 culverts on approach roads leading to the bungalows at which the afflux due to restriction of water way can cause flooding. These 5 culverts have to be remodelled if this drain is to function efficiently.

5.45 *Jor Bagh Drain.*—This drain discharges into the Kerbala under unfavourable condition. The bed level of the Kerbala drain is 684·20 and it flows nearly 4′ deep. The water level in the Kerbala drain is thus 688·20, the lowest point of Jor Bagh draining into the drain *via* the Jor Bagh Road drain is 686·13. Under these conditions Kerbala drain cannot take the run off from Jor Bagh area. Hence a separate outfall has to be provided or the Kerbala drain suitably deepened.

5.46 It is possible to deepen the Kerbala drain by providing a drop at the point A (plan 5·8) and the main drain along Jor Bagh Road can be connected to it downstream of the drop by a separate link B.C. The conditions of flow of the Kerbala drain after deepening it have been examined and it is seen that it can function satisfactorily. Deepening of the Kerbala drain will mean remodelling of 5 culverts in Aliganj and Lodi Road areas.

5.47 It is also observed from spot levels that the rain falling on the lawns in front of the Safdarjang Tomb also flows over Kutab Road and finds its way into Jor Bagh. In order to prevent this it is necessary to provide a catch water drain to intercept this flow and take into the Kerbala Drain. The proposed drain is shown marked K.L. on the plan No 5·8 sheet No. 2.

5.48 At present the two drains coming from the Aerodrome side meet head on, upstream of the culvert on Kutab Road creating terbulent conditions of flow. In order to improve conditions of flow it is necessary to provide a pipe culvert across the road to take the water of Aerodrome Drain coming from the South directly into Kerbala Drain. The proposed diversion is shown marked M.N. on the plan No. 5·8 sheet No. 2.

5.49 The total cost of this scheme works out to Rs. 1,56,000. The proposals are shown in plan 5·8 and the details of cost in annexure III.

5.50 *Improvement to Drainage of Golf Link Colony.*—The Golf Link Colony covers an area of 62 acres bounded by the Cornwallis Road on the North, Shan Nagar on the West, Lodi Road on the South and the Golf Link on the East. The general ground level slopes towards the culvert on the Lodi Road over outfall channel No. 3. The existing storm water drainage system as shown on plan 5·9 was designed for an *ad hoc* run off figure of 1 per hour. The branch drains fall into the stone pitched drain marked ABC which finally discharges into the covered outfall channel No. 3 just upstream of the culvert on Lodi Road through 2 hume pipes 2′·3″ dia.

5.51 The run off from the Golf Link Colony has been worked out on the basis of the approved coefficients and intensity of rainfall, the percentage of previous and impervious area being taken from Plan No. TP 132/1. It is observed that most of the plots are paved and the percentage of grassy area in the plots is about 20% of the plot area. On this basis the run off worked out to 0·94″ per hour. Hence the existing internal drainage system based on 1″ run off is adequate. The total run off from Golf Link Colony works out to 62 cusecs.

5.52 The main stone pitched drain ABC takes the entire discharge of Golf Link Colony as well as run off from a portion of the Golf Links. The area of the Golf Link draining into this drain as made out from contour plans of the Survey of India is about 90 acres. A suitable coefficient of run off for this area will be about 0·15 in view of the fairly rapid slope it has in the end portions towards the drain. On the basis of an intensity of 1.65″ per hour the run off works out to 23 cusecs. The total discharge of the stone pitched drain ABC is, therefore estimated at 85 cusecs.

5.53 The drain ABC has a slope of 1 in 750. For a discharge of 85 cusecs, the depth of flow will be 2·5′ and the velocity 3·8′ per second.

5.54 At the end, the drain discharges through 2 hume pipes 2′. 3″ dia. giving a water way of 7·6 sft. only as against 21 sft. upstream. This will cause an afflux of nearly 1·6′. The covered barrel has capacity when running ¾ full of about 933 cusecs whereas according to discharge calculations, for an intensity of 1·65″ per hour, the barrel has to take a discharge of nearly 1500 cusecs. In short, under peak conditions this barrel is likely to run full. The connecting drain from Golf Link discharges into the barrel with an invert level of 668·36. The bed level of the barrel is 663·37 and its top level 673·57. The road level in Golf Link Colony near this point is 673. Thus it will be seen that when the barrel runs full, the Golf Link Colony drains cannot flow. This perhaps is what happened during the last rains when this colony is reported to have been flooded to a depth of nearly 2½/for a short period. The conclusion is that storm water from Golf Link Colony should not be connected to the covered barrel (outfall channel No. 3).

5.55 Investigation has, therefore, been carried out to find a point in the Sonehripul Nallah to which the Golf Link Colony can be drained directly across the Lodi Road. A suitable point has been selected. It is now proposed to regrade the drain ABC so as to slope it towards the point C. From this point a barrel will be taken across the Lodi Road discharging into the Sonehripul Nallah. This barrel can discharge with an invert level of 668·43 running to a depth of 2·62′. The maximum water level in the Sunehripul Nallah at this point is expected to be 671·2 after the Mathura Road Bridge and the Barapula Bridge are remodelled as recommended separately.

5.56 The total cost of these improvements is estimated at Rs. 20,000. A plan showing the proposals and the details of the cost forms annexure IV of this report.

5.57 *Nizamuddin.*—Nizamuddin East and West are low lying areas draining into the Barapula Nallah direct. The storm water of the protected monuments East of the Mathura Road also finds its way to the Barapula Nallah through Nizamuddin. Nizamuddin West drains into the nallah upstream of the Mathura Road Bridge and Nizamuddin East downstream of this Bridge.

5.58 The general ground level of Nizamuddin West varies from 668 near the Barapula Nallah to 670 at the farthest end as shown in Plan No. 5·10. Nizamuddin East also slopes towards the nallah and the ground levels vary from 668 to 672. The outfall drains from the two colonies discharge into the Barapula Nallah with invert levels varying from 663·6 to 664·6.

5.59 The total area of East and West Nizamuddin including the protected monuments is 183 acres. The protected monuments cover 56 acres of area and is at a relatively higher level as compared to the colonies.

5.60 During the rains of July 58, almost the entire West Nizamuddin and a portion of East Nizamuddin were flooded. Detailed investigations have been made to determine the causes of flooding.

5.61 The levels of Barapula Nallah in this reach under various conditions of flow are as follows:

(a) Conditions of flow in the nallah when properly desilted for a ¼″ run off.

(*i*) When Jamuna is not in floods: R.L. 668 downstream of Mathura Road Bridge.
R.L. 670·5 upstream of Mathura Road Bridge.

(*ii*) When Jamuna is in floods : R.L. 670·2 downstream of Mathura Road Bridge.
R.L. 672·9 upstream of Mathura Road Bridge.

(b) When the drainage system is augmented for increased run off:

(*i*) When Jamuna is not in floods: R.L. 668·8 downstream of Mathura Road Bridge. R.L. 671·6 upstream of Mathura Road Bridge.

(*ii*) When Jamuna is in floods : R.L. 670·3 downstream of Mathura Road Bridge. R.L. 673·5 upstream of Mathura Road Bridge.

5.62 It will be seen from the above data that the drainage system of East and West Nizamuddin cannot function when the Barapula Nallah is flowing to its capacity, the conditions being worse upstream of the Mathura Road Bridge. Proposals have been made separately for remodelling the Mathura Road Bridge and the Barapula Bridge. With these modifications, the level of water in the Nizamuddin reach will be R.L. 668 when Jamuna is not in floods and 669·3 when Jamuna is in floods. Even when the Bridges are remodelled therefore, the drainage system of Nizamuddin East and West cannot function when the Barapula Nallah is flowing to designed capacity.

5.63 As this area cannot be drained by gravity under such circumstances, pumping seems to be the answer. The protected monuments area, which is relatively high, can be drained by gravity. This area is excluded from the pumping scheme.

5.64 On the basis of approved coefficients the run off for the area comes to ·75/ per hour. The total discharge from Nizamuddin East and West covering 128 acres thus works out to 96 cusecs.

5.65 It is proposed to provide a sump and a pumping station capable of dealing with this entire discharge. The capacity of the sump will be for 10 minutes flow and it is proposed to site it at the place indicated in the plan. This site is very low and does not seem to be suitable for development. A main barrel varying from 30″ to 73″ will be laid to intercept the discharge of the various outlet drains and discharge into the sump. The existing outlets will be provided with non-return flaps to prevent back flow from Barapula Nallah. Three pumps of 70 B.H.P. each will be installed to pump the water from the sump into the nallah. A new intercepting drain will be provided for the high level area of the protected monuments.

The scheme is estimated to cost Rs. 7,20,000 and details of the proposals and cost are shown in annexure 7.

5.66 As the above scheme means a recurring expenditure on pumping, further investigations will be carried out to find if this area can be drained into the river through other outfall channels. From the data available such a possibility is rather remote.

5.67 *Improvement of Nallahs to take increased run off.*—The Barapula Nallah takes almost the entire storm water of New Delhi as well as unbuilt and rural areas of major part of Block I. The total catchment of this nallah is 34,400 acres. Its main tributaries are the Kushak Nallah, Chiragh Delhi Nallah and Sunehripul Nallah. Brief descriptions of the existing conditions of these nallahs are given below:—

5.68 *Kushak Nallah.*—The Kushak Nallah emanates from the ridge at a point near Panchkuin Road and runs for a total length of about 40,000 ft. before it falls into the Barapula Nallah. Upto its crossing on Kitchner Road this nallah has no well defined section. Beyond the Kitchner Road the nallah has fairly well defined sections, slopes and banks as shown in Plan 5·11. The bed width of the nallah varies from about 30 ft. at Kitchner Road to about 210 ft. where it joins the Barapula Nallah. The existing bed level of the nallah near the Kitchner Road is R.L. 715 and it drops to 673 at the point where the nallah meets the Barapula Nallah. There are a number of vertical drops provided in the entire length of this nallah in order to reduce slope. At present the bed of this nallah is considerably silted up and the silting is about 2 ft. above the top of the connette level in many places and by suitably desilting this nallah the available slopes will be varying from 1 in 1100 to 1 in 2000.

The total catchment of the Kushak Nallah is 9395 acres.

5.69 *Chiragh Delhi Nallah.*—This nallah drains the rural and unbuilt areas to the South of Delhi. Its section is ill-defined upto the point where it enters Defence Colony beyond which point it has a fairly well-defined section. The bed width of the nallah near Defence Colony is 70 ft. and the bed width at the point where it joins the Kushak Nallah is 100 ft. The bed level of the nallah where it enters Defence Colony is 677·00 and the bed level where it enters the Kushak Nallah is 671·00. The total length of the nallah is approximately 7000 ft.

5.70 *Sunehripul Nallah.*—This nallah takes off from the outfall channel No. 3 at the culvert on Lodi Road and finally falls into the Barapula Nallah. Its width at the start is about 80 ft. For a length of about 1000 ft. the nallah has well-defined banks but beyond that the bank on the right side disappears Further downstream, however, the nallah has fairly well-defined banks again and the width of the nallah where it finally falls into the Barapula Nallah is about 160 ft. The bed level varies from 667 at its start to 564 where it joins the Barapula Nallah. This nallah has fairly large connette to take the dry weather flow which consists mostly of sewage over flow and sub soil water flow.

5.71 The catchment of this nallah is approximately 7230 acres which consists mainly of the built up area of New Delhi.

5.72 *Barapula Nallah.*—The Barapula Nallah takes the water of Chiragh Delhi Nallah, the Kushak Nallah and the Sunehripul Nallah. After crossing the Mathura Road and the Ring Road it finally discharges into the Jamuna. Throughout its length upto the Barapula Bridge the nallah has a fairly well-defined section with a bed width of 210 ft. at the start widening to about 300 ft. at the Barapula Bridge. Beyond the Barapula Bridge however the nallah has no banks and only a dry weather stream meanders across low lying land between Barapula Bridge and Ring Road passing the Ring Road under the newly constructed Bridge and finds its way finally into the Jamuna upstream of the weir at Okhla. During the monsoon and when the Jamuna is in floods the entire low lying area beyond Barapula Bridge gets flooded and the nala water mixes with the Jamuna water immediately after crossing the Barapula Bridge.

5.73 The total catchment of this nala ia about 34,400 acres. Detailed investigations on the above nalas have been carried out with a view to suggest schemes on the assumption that the drainage system will be fully augmented to the capacity recommended, namely to be capable of taking the maximum intensity of rainfall likely to occur once in two years.

5.74 The time of concentration of the tributary nalas have been taken as 1 hour while for Barapula Nala which is the longest of these nallas, it is roughly 2 hours. This works to 1·65" of rainfall per hour for tributaries and 1" intensity in the case of Barapula Nalas the calculations of discharges have been made on the basis of coefficient of rougosity of 0·023 in Manning's formula. The flow in the Barapula Nala has been examined under two conditions namely when the river is not in floods as shown in plan 5·12 and secondly when the river is in floods. The high flood level of the river assumed is obtained by interpolation from the highest flood levels observed at the Jamuna Bridge and Okhla Weir during the record floods of 1956. The H.F.L. obtained at the Barapula Bridge by such interpolation is 669·26.

5.75 *The results of the investigations made on the Nalas.*—The Kushak Nala in its upper reaches for a length of about 13000′ does not have proper slopes and sections with the result that there is no proper flow. It is necessary to regrade the nala in this reach with adequate section to carry the discharge. The catchment of the nala in this reach consists mainly of the run off from the ridge which works out to ¾" per hour. The total discharge from this catchment works out to 578 cusecs. In order to enable the nala to effectively drain this run off, it is proposed to regrade the nala providing a slope of about 1 in 1250. Behind the Camp College, the Nala passes through a brick barrel over which is the approach to the playground. This brick barrel has at present a reverse slope. It is necessary to dismantle this barrel and provide proper section of nala with a culvert to provide access to the playground behind the Camp College. An estimate amounting to Rs. 1,86,000/- has already been submitted to the Government covering these proposals which also includes the cost of remodelling some of the existing culverts.

5.76 In the lower reaches the nala has the necessary slopes and sections to carry the entire discharge upto the Barapula Nala. At present, however, the bed is silted up and in certain places the depth of silting is about 2 ft. If properly desilted the Nala can take the entire discharge. Estimated cost of desilting the nala is given as annexure VI to this report.

5.77 *Sunehripul Nala.*—As stated before this nala has no defined banks for a major portion of its length. In the earlier reaches its width is about 80 ft. In the intervening portion there is no defined bank for the nala. Due to the restricted width in the initial reaches the water level becomes too high to enable outfall channel No. 3 and Golf Link Colony to discharge effectively. If the width is increased to 150 ft. the depth of flow will reduce by 2′0". The maximum water level in this nala will then be 671·2 which will permit of efficient flow from outfall channel No. 3 and proper drainage of Golf Link Colony, will be ensured. The proposals are shown in Annexure V to this report. The cost of desilting the nala and widening its upper reaches will be approximately Rs. 78,000/-. Details of the cost are attached as annexure V of this report.

5.78 *Chiragh Delhi Nala.*—Detailed investigations of this nala have not so far been completed. The preliminary surveys indicate that there is no flooding problem in this catchment.

5.79 *Barapula Nala.*—The hydraulic conditions of the Barapula nala have been examined in detail. The run off adopted from various areas is as follows:—

Pre-1939 New Delhi : At present the drainage system is designed for ¼" run off. When it is augmented, the run off will be 0·33" for 1" intensity of rainfall, the run off factor being 0·33. (The time of concentration for this nala is 2 hours against 1 hour for main drains).

Part-1939 Colonies : The internal drainage arrangements are adequate and the run off is calculated at 0·33" per hour for 1" intensity of rainfall and run off coefficient of 0·33".

Rocky areas : The run off coefficient is 0·5 and hence the run off is 0·5"

Unbuilt areas : The run off coefficient is 0·2 and hence the run off will be 0·2".

Rural areas : The run off is taken as 10 cusecs per sq. mile as already approved by the Technical Sub-Committee.

On the basis of the above data the condition of flow in the nala will be as follows:—

5.80 *Under existing conditions of drainage.*—The total discharge works out to 6650 cusecs as below:—

Built up areas . . .	6,600 acres	@ 1-4" run off	1,650 cusecs.
	8,800 acres	@ ·33" run off	2,640 cusecs.
	1,200 acres	@ ·5" run off	600 cusecs.
Unbuilt areas . . .	8,000 acres	@ ·2" run off	1,600 cusecs.
Rural areas . . .	10,000 acres	@ 10 cusecs per sq. mile.	156 cusecs.
			6,646 cusecs.
		Say	6,650 cusecs.

5.81 Under this condition the normal depth of flow in the nala is 5·5 ft. Due to restriction of water way at the Mathura Road Bridge *vide* plan No. 5·12 (not the new bridge) and the Barapula Bridge, there is afflux of 2·1′ and 1·8′ respectively at these two bridges and the ultimate water level in the Sunehripul Nallah works out to 670·57 at the tail end and 671·27 at the outfall channel No. 3.

5.82 When the river is in floods, the ultimate water level in Sunehripul Nala will be 672·93 at the tail end and 673·6 at the outfall channel No. 3.

5·83 When the drainage system is augmented the total discharge works out to 7440 cusecs as below :—

Built up areas	15,400 acres	@ ·33″ run off	5,080	cusecs.
	1,200 acres	@, ·50″ run off	600	cusecs.
Unbuilt up areas	8,000 acres	@ ·2″ run off	1,600	cusecs.
Rural areas	10,000 acres	@ 10 cusecs per sq. mile	156	cusecs.
			7,436	cusecs.
		Say	7,440	cusecs.

5.84 Under this condition the normal depth of flow in the nala is 5·9 ft. The afflux caused at Mathura Road Bridge is 2·74 ft. and at the Barapula Bridge 1·92 ft. and the ultimate water level at Sunehripul Nala is 671·66 at the tail end and 672·36 at the outfall channel No. 3.

5.85 When the river is in floods, the ultimate water level at Sunehripul Nala is 673·6 at the tail end and 674·3 at the outfall channel No. 3.

5·86 Outfall channel No. 3 which falls into the Sunehripul Nala has a water level of 670·86 when running ¾ full. If this channel, which takes the major portion of the run off from the pre-1939 capital is to function efficiently, the water level in Sunehripul Nala at this point should not exceed 671 at the most. It is seen that this condition of satisfactory flow exists at present provided the river is not in high flood. After augmentation of the drainage system however outfall channel No. 3 cannot function efficiently unless the afflux at the bridges is reduced. The reduction in afflux could be achieved either :—

(a) by deepening the Barapula Nala.

or (b) by remodelling the Bridges.

5.87 The possibility of deepening the Barapula Nala has been examined. It is seen that this cannot be done as the bed level at the Ring Road Bridge will have to be reduced to 657 whereas the top level of the well foundations of this Bridge is 661.

5.88 The only alternative is therefore to remodel the Mathura Road Bridge and the Barapula Bridge so as to have no afflux conditions. With these bridges so remodelled, the maximum water level in Sunehripul Nala will be 671·2. Under this condition outfall channel No. 3 can function effectively.

5.89 The total cost of remodelling both the bridges will be roughly Rs. 12 lakhs. It is also proposed to canalise the nala between the Railway Bridge and the National Highway. At present this portion of the nala has no well-defined banks and during floods the low lying area between the two bridges acts as a breathing section. If the nala is canalised the water level in the nala will rise quickly and the preliminary investigations indicate that the water level will touch the bottom of the girder of the Railway Bridge. As this may not be acceptable to the Railway a lump sum provision of Rs. 6 lakhs has been made for constructing a syphon across the bridge. Remodelling of the bridge in view of its proximity to the Railway Yard will be considerably more expensive. The Barapula Bridge perhaps can be dismantled and need not be reconstructed as Mathura Road Bridge provides the access across the Barapula Nala. If only Mathura Road Bridge mentioned above is remodelled and the Barapula Bridge dismantled the likely cost will be about Rs. 7 lakhs.

5.90 *Lajpat Nagar Nala.*—This is a well-defined nala which was canalised and provided with brick pitching at the time of construction of Lajpat Nagar and Jungpura etc. It finally falls into the Barapula Nala. During the heavy rains of July and September 1958 this nala overflowed its banks and flooded low lying areas of Lajpat Nagar and Jungpura. Preliminary investigations indicate that this nala will need remodelling so as to increase its capacity. At present the nala has got a capacity of 600 cusecs whereas the total ultimate discharge is estimated to be 960 cusecs. Detailed investigations for the improvement of this nala have not been completed and the approximate cost of remodelling it will be Rs. 1,65,000/-. This does not include the cost of remodelling the road bridges and the railway bridge. A lump sum provision has been made in the project estimate for remodelling of road bridges in general, which, it is anticipated will cover the Lajpat Nagar bridge also. As regards the railway bridge, this is mainly the responsibility of the railway, hence is not included in the project estimate.

5.91 From the foregoing facts it will be seen that the following improvements are necessary to the nallas as far as can be seen at present :—

(a) Widening and desilting of the Sunehripul Nala.

(b) Increasing the capacity of Lajpat Nagar Nala.

(c) Desilting of the Kushak Nala and the Barapula Nala.

(d) Dismantling and remodelling of the Barapula and the Mathura Road Bridges.

5.92 The total cost of improvements necessary for the other nalas in this block has been worked out on the basis of the above sample survey.

5.93 *Friends Colony Nala.*—This nala is also reported to have overflowed during the rains of July 1958. Detailed investigations have, however, not been completed. Preliminary data collected reveals that the nala has inadequate capacity and some culverts will have to be remodelled. Rough cost of remodelling the nala has been given in the project estimate and the cost of remodelling the culvert is anticipated to be covered by the lump sum provision made for bridges in general.

5.94 *Local Spots—Depression under the Minto Road Bridge.*—Water accumulates in the depression under the Railway Bridge during the Monsoon dislocating traffic between the Old and New Delhi area. Detailed investigation into the causes of floodings has been carried out and action has already been taken to improve the drainage arrangements of the Railway Yard, both on the Connaught Place side and the Minto Road side. This will prevent rainwater from the roads entering into the depression.

5.95 A scheme for providing additional pumps of the vertical type has also been prepared by the Corporation authorities. With the completion of these works chances of flooding of the Minto Road depression are remote.

5.96 To a lesser extent the depression under the Hardinge Bridge is also subjected to flooding in case of very heavy rainfall. Detailed investigations into the causes of flooding have not been carried out but the improvements will be similar to those carried out in the case of the Minto Road Bridge.

5.97 *Storm water Drainage of Quarters on Market Road.*—Quarters on the Eastern side of Market Road get flooded very often. During the rains of July '58 it was reported that storm water stagnated to a depth of about 3' in this area. The drainage system of this area was therefore examined to locate the causes of flooding.

5.98 *Existing system.*—The area bounded by Market Road, Market Lane, Baird Road and Baird Lane partly drains into the open surface pitched drain 1'×2'-2" size which runs along the Eastern berm of Market Road as shown in plan.

5.99 Major portion of the drain slopes from Gole Post Office side towards Gole Market side at grade of 1 in 131. In a length of 250 ft. it has a slope from Gole Market towards Gole Post Office. At the junction of these two slopes a small chamber is located. This chamber is connected by 18" diameter pipe across the road to a covered barrel of 36" diameter running on the Western berm of Market Road.

5.100 The 36" diameter barrel has its origin at the junction of Peshwa Road and Reading Road. It joins 36" diameter barrel coming from Havelock Road as shown on plan 3·1. This drain is designated as 1(B). Its catchment area is 116 acres. It could take 27·78 cusecs while running ¾th full. Thus the size of the barrel is slightly under-size to take ¼" discharge from its catchment.

5.101 Invert level of the chamber referred to above is 700·75. The invert level of 18" diameter barrel where it joins 36" diameter barrel is 700·86. This is indicated in plan No. ....Thus the connecting link of 18" diameter is not able to discharge freely when drain No. 1(B) is running ½ or ¾ full. Moreover the hydraulic gradient of Drain No. 1(B) does not permit low lying area on the Eastern side of Market Road to be drained into the barrel.

5.102. *Causes of Flooding.*—Unsatisfactory interception of water from lawns and pitched drains in this low lying area is one of the causes of stagnation of water. Other causes of stagnation are —The diameter pipe culverts across the service roads are inadequate in size and lawns are not graded to drain water towards peripherial drains.

5.103 Major cause of flooding is the flow of storm water from other high areas into this low lying ground. Average ground level of Market Road area is 704·27. The average ground level of the Market Road crown is 706·70. Market Road itself is sloping from Gole Market towards Gole Post Office with a fall of 1 in 1250. Storm water flowing along the kerb channels of this Road finds its way through depressions in cycle track on the eastern berm into the service lanes behind the quarters.

5.104 *Proposed storm water drainage system.*—The following remedial measures are suggested :—All the branch drains are to take ¾″ run off while the main open drain will cater for ½″ run off from an area of 36 acres.

5.105 *Open surface drain.*—It is proposed to regrade and resection the existing main surface drain of 12″ x 26″ size to 3′ × 2′-10½″ size, The proposed drain will have a bed slope of 1 in 1000 from Gole Market to Gole Post Office side. This would enable it to carry 20 cusecs of discharge more. The proposed drain would ultimately join 45″ dia. barrel running along Havelock Road.

5.106 *Catchwater drain.*—To prevent storm water from flowing into the low lying area from nearby elevated areas, it is proposed to widen catchwater drain on Baird Lane from 9″ x 9″ to 18″ x 9″.

5.107 *Raising the level of Cycle Track on Eastern Berm.*—The longitudial section of the road kerb line and the cycle track on Eastern berm is plotted. It is seen that through the depressions in the track water from the Market Road (which itself has a longitudial slope towards Gole Post Office) must be rushing to the service lanes behind quarters. It is therefore proposed to elevate cycle track to a level higher than the Kerb channel level of the Market Road. This would prevent out side water flooding this area.

5.108 *Intercepting drain on Western Berm.*—To intercept water from the Western berm and bungalow compounds it is proposed to construct open surface drains 9″ x 9″ size in place of katcha drains existing at present. These drains will be connected through gully gratings to existing 36″ barrel *i.e.*, drain I(B) on the Western berm at intervals. The total area to be drained from Western berm is 9 acres.

5.109 *Cost of the Scheme.*—These measures could be put through without waiting for augmentation of other drains like I-C. The estimated cost of improvements suggested above would be Rs. 18,750/-/- works-outlay.

6. Sewerage Systems in Block I

6.1 One of the terms of reference of the Main Committee is to examine the adequacy of the existing sewerage system and to suggest necessary improvements. It has not so far been possible to carry out the detail investigations. The deficiencies that have come to light as a result of preliminary survey are dealt with in the following paragraphs.

6.2 The major portion of New Delhi excepting a few outlying colonies is served by a separate sewage system. An index plan showing the trunk sewers and the main sewer lines is attached to this report.

6.3 The sewered portion of New Delhi area is served by 2 trunk sewers. The first trunk sewer 'A' starts from Old Delhi and enters New Delhi near Hardinge Bridge. It runs parallel to Mathura Road, than along Hardinge Avenue, cuts across India Gate, then goes on to Shahjehan Road and Prithviraj Road. It then bifurcates into two trunk sewers 'B' and 'C' which pass on through New Delhi to the Kilokri pumping station. Another trunk sewer starts from Vinay Nagar and ends again at the Kilokri pumping station. There is no evidence of any sewerage problems in the areas served by the Vinay Nagar Trunk sewer. There is however evidence of overloading in the trunk sewers A, B and C as also in some of the main sewers feeding them. A brief description of these trunk sewers and the main sewers feeding them in the New Delhi area is given in the following paragraphs.

6.4 Trunk sewer A is 75″ diameter where it enters New Delhi area and its size increases to 84″ at Prithvi Raj Road. Trunk sewers B and C are both 66″ diameter throughout their length upto Kilokri. At present this system is over loaded and is provided with an overflow into the Storm water drainage system at Q point. Trunk sewers B and C are syphoned under the nalla coming from the Wireless Station behind Lodi Colony. Due to over load these sewers have burst at some points in the syphon and sewage flows out into the nalla which ultimately goes into the Sunehripul Nala. The Delhi Municipal Corporation are laying a new trunk sewer from Delhi Gate to Okhla which when completed is expected to relieve the trunk sewers A, B & C of a considerable portion of the sewage and storm water of Old Delhi area and obviate the necessity of overflow into the storm water drainage system. Till such time as this new trunk sewer is completed no relief to this system is possible.

6.5 There are eleven main sewers in New Delhi area feeding the trunk sewers A, B and C. The problems concerning them as far as known are described in the following paragraphs.

6.6 Main sewer No. 1 starts from Paharganj, runs along Chelmsford Road, through Connaught Circus, then along Curzon Road and joins the trunk sewer "A" at India Gate. Its size varies from 27" to 39". There is no report of overloading in this sewer.

6.7 Main sewer No. 2 runs along Panchquin Road and joins the main sewer No. 1 at Connaught Circus. Its size varies from 9" to 21". This sewer is at present overloaded and over flows through a manhole in its head reach. This overflow has been temporarily checked by raising the level of the manhole. The position, however, worsens in the monsoons. It is therefore necessary to provide a relief sewer along Panchquin Road.

6.8 Main sewer Nos. 3 and 4 start from Gole Post Office run along Ashoka Road, Man Singh Road and discharge into the trunk sewer at Q point. Though this sewer does not appear to have overflowed so far, it is reported to be running full. The load on these sewers has increased considerably as a result of the New Multistoreyed Buildings that have come up at the junction of Ashoka Road and Parliament Street. It will therefore be necessary to lay a relief sewer to reduce the load on these sewers.

6.9 Main sewer No. 5 starts from North Block runs between Queen Victoria Road and Raisina Road and joins the main sewer No. 3 at the junction of Mansingh Road and Ashoka Road. It is 12" diameter throughout. This sewer is also reported to be overloaded and either its size shall have to be increased or a relief sewer provided.

6.10 Main sewer No. 6 starts from the junction of South Avenue and Roberts Road, runs along Roberts Road and then roughly parallel to Akbar Road and Tees January Marg, cuts across Aurangzeb Road and joins the trunk sewer at Prithvi Raj Road. This sewer has adequate capacity. Its size varies from 12" to 30".

6.11 Main sewer No. 7 starts from South Block runs along York Road, King Edward Road and joins the trunk sewer at India Gate. Its size varies from 12" to 15". This sewer is functioning satisfactorily.

6.12 Main sewer No. 8 starts from Sunehribagh, runs along York Road and meets the trunk sewer at Q point. Its size varies from 15" to 21". There are no complaints about this sewer.

6.13 Main sewer No. 9 starts from Club Road runs along Aurangzeb Road and Akbar Road and joins the trunk sewer at Prithvi Raj Road. Its size varies from 9" to 15" and it does not appear to be overloaded.

6.14 Main sewer No. 10 starts from Tughlak Crescent runs along Prithvi Raj Road and joins the trunk sewer at Prithvi Raj Road. There are no complaints about this sewer.

6.15 Main sewer No. 11 starts from Jor Bagh runs along Jor Bagh Road, and Third Avenue of Lodi Colony and falls into a sump at the end of Fifth Avenue of Lodi Colony near the Kushak Nalla. Its size varies from 9" at the start to 24" where it falls into the sump. From this sump the sewage is pumped up through a 24" rising main into the trunk sewer at a point near Jangpura. Main sewer No. 11 was originally designed only to cater for Lodi Colony and Aliganj. But now Jor Bagh is also connected to this sewer and hence it is overloaded. Further the pumping arrangements at the tail end of this sewer are now inadequate due to the additional sewages flow from Jor Bagh. Consequently main sewer No. 11 overflows through some of the manholes in Lodi Colony. This overflow from the manholes as been temporarily stopped by providing a by pass for the excess sewage into the storm water drainage system. As long term measures however it will be necessary to augment the pumping arrangements and perhaps also to provide relief sewers. A scheme for augmenting the pumping capacity at a cost of about Rs. 1 lakh is already under the consideration of the Delhi Municipal Corporation.

6.16 As detailed investigations have not been carried out, it is not possible to estimate the cost of the improvements necessary to the main sewers. These are however expected to cost roughly Rs. 7 lakhs. This does not include the cost of laying a new sewer along Barakhamba Road which it is understood is being taken up shortly by the N.D.M.C.

6.17 The outlying private colonies like Green Park, Hauz Khas, Kailash and Friend's Colony are not at present sewered and the Corporation have included the cost of providing sewers in these areas in their project estimate. Of the Rehabilitation colonies, Lajpat Nagar has sewerage system excepting in a small portion. The other colonies *viz.*, Kalkaji and Malvia Nagar are being provided with internal sewers by the Ministry of Rehabilitation and action for providing out fall sewers for these two colonies is being taken jointly by the Corporation and the Ministry of Rehabilitation. These schemes have not therefore been included in the project estimate for Block I.

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SUMMARY

The improvements necessary to the existing drainage system in Block 1 can now be briefly stated as follows :—

1. The drainage system in pre-1939 New Delhi is at present capable of taking only a run off of 1/4" per hour. This will have to be augmented to take the run off due to a rainfall of intensity of 1·65" per hour which will mean a run off of about 3/4" in the case of branch drains and 1/2" in the case of main drain. The improvements will take the shape of enlarging open branch drains, laying additional branch drain and duplicating the main barrels. Side by side the interception arrangements will also have to be improved by providing more gully gratings, and adopting improved methods of interception.

2. In the case of new colonies built after 1939, flooding is due to either unfavourable conditions as in the case of Golf Link Colony and Jor Bagh or due to the high level of water in the outfall nallas in the case of Nizamuddin. In the former case, outfall conditions will have to be improved and in the latter case, pumping arrangements will have to be provided as a standby.

3. The capacity of outfall channel No. 3 should be augmented firstly to take the full discharge under existing condition of run off and secondly to take the improved discharge when the entire drainage system is remodelled.

4. The nallas will have to be desilted first and secondly remodelled to take the improved run off.

5. Bridges and culverts across drains and nallas will have to be remodelled whenever necessary to take the improved discharge without causing undue afflux.

As regards sewerage preliminary investigations indicate that there is over loading in the Trunk Sewer which starts from Old Delhi passes through New Delhi and goes on to Kilokri Pumping Station. The Delhi Municipal Corporation are laying a new Trunk Sewer from Delhi Gate to Okhla which when completed will relieve this over loading. Apart from this there is evidence of over loading of the Main Sewers serving Panchquin Road, Asoka Road and Lodi Colony. Detailed investigations have not been completed but it appears necessary to either enlarge the overloaded Main Sewers or to provide relief sewer. In the case of the Main Sewer serving Lodi Colony, it is also necessary to augment the pumping capacity at its tail end. The probable cost of improvements to these Main Sewers will be approximately Rs. 7 lakhs. The project estimate prepared is on the basis of the sample survey conducted within a brief period of 2 months. It is pointed out that the cost of remodelling railway bridges is not included in this estimate and this will mainly be the responsibility of the railways. Considerable amount of detailed investigations are yet to be carried out before all the necessary schemes can be formulated. The project estimate can at best therefore be considered as a rough guide to the total likely expenditure involved.

It will not be practicable to hold up the schemes formulated from time to time till the entire investigations are completed. Hence investigations will be made in order of priority, schemes considered necessary to be implemented before the next monsoon being given the first place. The remaining schemes will be taken up in phases in the order of urgency and practicability. These schemes will be submitted to the Government for sanction as and when they are ready. With the present sanction of staff, it is anticipated that the entire investigation will be completed by end of April, 1959.

Ultimately efficiency of any drainage system depends to a large extent on the standard of maintenance. Choking of outlet pipes and silting the channels and nalas should be cleared up well in time before the monsoon. The existing standard of maintenance leaves much to be desired and in order to reap the full benefit of the proposed improvements, it is necessary to improve the standard of maintenance also. This aspect of the problem will have to be examined by the N.D.M.C. and the Corporation and suitable steps taken.

Costs & Phasing

The total estimated cost of remodelling the drainage system of Block No. I works out to Rs. 2·37 crores. Improvement to Sewerage will cost another Rs. 7 lacs (*vide* Annexure VIII). This cost does not include the cost of raising of lawns, improvement to drainage by the *ad hoc* committee on Sub-soil water of open areas already recommended for execution. While it is desirable to carry out all improvements suggested above immediately the completion of this project is bound to take considerable time. Therefore, the work required to be done has been sub-divided into :—

(*a*) Emergent works, *i.e.*, works that should be completed before the next monsoon.

(*b*) Works of an urgent nature that should be taken up for execution as soon as the final investigations are completed.

(*c*) Remaining works envisaged in the project.

Phase I—Emergent Works

(*i*) Desilting and sectioning of the nalas as per designs.

(*ii*) Relief drain behind the Fire Brigade Lane.

(*iii*) Remodelling of the Kerbala drain to prevent flooding Jor Bagh area.

(*iv*) Providing an independent outfall for Golf Link Colony.

(*v*) Improvement to the drainage of the Market area.

(*vi*) Improvement to the drainage of Minto Road Quarters.

(*vii*) Regrading of the Kushak Nala in its upper reaches.

(*viii*) Improvements to drainage and provision of pumps under Minto Road Bridge.

(*ix*) Improvements to main Sewers at Punchkuin Road, Ashoka Road and Lodi Colony (Rs. 7 lacs).

TOTAL Cost—18,35,000/-

Phase II—Urgent Works

1. Improvement to the interception arrangement along the road and round abouts.
2. Providing open surface drains where they do not exist.
3. Augmenting the capacity of the outfall channel No. 3 from Q point to Sunehripul Nala.
4. Providing additional drains along Punchkuin Road, Barakhamba Road, Aurangzeb Road, York Road, Akbar Road, Prithvi Raj Road, Kushak Road, Chelmsford Road and Ashoka Road.
5. Remodelling of the Mathura Road Bridge and the Barapula Bridge to give relief to the heading up of water in Sunehripul Nala, Lajpat Nagar Nala and outfall channel No. 3.
6. Remodelling of Lajpat Nagar Nala.

Phase III

The remaining works of the project not covered by phase I & II.

Time.—The completion of this scheme is bound to take considerable time. The remodelling or duplicating the existing drainage system through built-up areas will present lot of difficulties. Neither would it be practicable nor would it be wise to start construction of additional underground barrels all along the existing roads simultaneously. It would be desirable to complete remodelling of one complete drainage channel and then take up the next. Further the progress on the work will be considerably hampered due to the high subsoil water in the New Delhi area. It is roughly estimated that the completion of all the schemes now proposed would take between 5 to 6 years.

TABLE NO. 1

HYDRAULIC PARTICULARS DRAIN I-C & DUPLICATE LINES

Reach of Drain I.C.	Catchment area Acres	Total run off from catchment on ½ run off basis	Existing Dia.	Bed slope 1 in.	Capacity at ¾" full cusecs	Dia. of the duplicate line required	Bed slope 1 in.	Capacity of duplicate line ¾" full cusecs	Total Capacity after augmentation cusecs	Remarks
1	2	3	4	5	6	7	8	9	10	11
			inches			*inches*				
1	62·21	31·11	24	250	13·20	27	250	19·38	32·58	Starting point on Reading Road.
2	84·25	42·13	33	300	28·44	27	300	17·69	46·13	
3	120·06	60·03	33	300	28·44	36	300	38·69	66·53	
4	130·39	65·20	36	400	31·09	39	400	40·84	71·93	
5	238·32	119·16	45	325	62·65	45	325	66·47	129·12	
6	292·54	146·27	54	400	91·89	45 & 63	400	59·81	151·70	45" Dia. Duplicate section for 810' length, 63" dia. for remodelled section 600' Length.
7	393·29	196·65	54	400	91·89	57	400	112·36	204·25	
8	434·45	217·23	60	500	108·71	60	500	115·23	223·94	
9	512·36	256·18	66	600	135·04	66	600	135·63	270·67	
10	604·39	302·20	84	900	197·27	69	900	124·69	321·96	'R' point.

ANNEXURE I

Rough Estimate of Cost (Augmentation)

(*a*) Total length of drain No. I-C from Reading Road to 'Q' point is 15695 ft. Cost of improving the interception arrangement all along this drain has been estimated at Rs. 2,74,000 that is Rs. 17·50 per Rft. of the main drain.

The estimate covers:—

(1) Regrading of road berms.

(2) Provision of road side drains where such drains do not exist.

(3) Provision of gully gratings and 6" dia. R.C.C. link pipes.

(4) Improvement to drainage of road islands.

(*b*) Total length of drain No. I-C from Reading Road to 'R' point is 10895 ft. Cost of remodelling or duplicating the drainage system as discussed above is estimated to be Rs. 9,77,000; this gives a figure of Rs. 90·00 as cost of augmenting the capacities of the covered barrels per Rft.

(*c*) Cost of duplicating lines from 'R' point to 'Q' point is estimated to be Rs. 21,84,000 or Rs. 455 per Rft.

(*d*) Taking these as unit rates for working out the cost of remodelling entire drainage system of New Delhi to take 1/2" run off from their catchments upto 'Q' point would be as follows :—

		Total cost
1.	Improvement to interception along drains :	
	1, IE, I-C, I-B, I-D, No. 2, 3, 3B, 3C, 3D, 4 and 5 1, 14, 600 Rft. @ Rs. 17·5 per Rft.	Rs. 20,05,500
2.	Duplicating or remodelling the existing drainage system of the above drains:	
	1,05,000 Rft. @ Rs. 90·00 per Rft.	94,50,000
3.	Duplicate line for drains I-C, IE and I from ' R ' point to ' Q ' point:	
	9,600 Rft. @ Rs. 455 per Rft.	43,68,000
	TOTAL . . .	1,58,23,500
	Say . .	1,60,00,000

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ANNEXURE II

Estimate for augmenting the capacity of outfall channel No. 3 from 'Q' point to Sonehripul

Phase I:—Providing Relief Channel between 'Q' point and Khan Market along Humayun Road and Cornwallis Road:

1.	Covered conduit from 'Q' point to Khan Market including cost of making connections (capacity 972 cusecs) 2710 Rft. @ Rs. 595 per Rft. .	Rs. 16,12,450
2.	Construction of chamber near Khan Market Cubic capacity 25,600 Cft. @ Rs. 8 per Cft.	2,04,800
		18,17,250
3.	.... 3% Contingencies	54,518
		18,71,768

Phase II:—Providing Relief Channel between Khan Market and Sonehripul :

1.	Covered conduit 3280 Rft. @ 240 per Rft. (Capacity 567 cusecs)		7,87,200
2.	Remodelling at Sonehripul Bridge	L.S.	25,000
			8,12,200
3.	Add 3% contingencies		24,366
			8,36,566

Total cost of improvements to outfall channel No. 3 : : 18,71,768 plus 8,36,566 : : Rs. 27,08,334.

Say Rs. 27,10,000

ANNEXURE III

Estimate of cost for improvement of drainage of Jor Bagh

	Rs.
1. Deepening and repitching the Kerbala drain 4800 rft. @ Rs. 18 per rft.	86,400
2. Reconstruction of culverts on Kerbala drain 5 Nos. @ Rs. 7,500 each	37,500
3. Constructing drap wall	800
4. Regrading Jor Bagh drains	4,500
5. Remodelling approach culverts on Lodi Road drain and Jor Bagh drain. 25 Nos. @ Rs. 400 each	10,000
6. Providing intercepting drain from Safdarjang Madarsa to Kerbala drain	2,000
7. Providing new covered barrel across Jor Bagh Road	5,000
8. R.C.C. pipe across Qutab Road	5,000
	1,51,200
Add 3% contingencies	4,536
	1,55,736
Say	1,56,000

ANNEXURE IV

Estimate of cost of Improvement to Golf Link Colony Drainage System

	Rs.
1. Regrading Existing drain ABC. 1200 rft. @ Rs. 105 per rft.	6,000
2. Providing new cross barrel to Sonehripul Nala across Lodi Road 120 rft. @ Rs. 104 per rft.	12,480
3. Stone pitching at downstream end of barrel. 1230 sft. @ Rs. 40 per % sft.	492
Miscellaneous items	500
	19,472
Add 3% contingencies	585
	20,057
Say	20,000

ANNEXURE V

Estimate of cost of desilting and widening Sonehripul Nala in the Upper reaches

	Rs.
1. Earth work in Excavation (lift upto 5′—0″) 2500,000 cft @ Rs. 24 per 1,000 cft.	60,000
2. Extra for lift. 15,00,000 cft @ Rs. 2 per 1,000 cft.	3,000
3. Removal of silt from cunnette. 26,400 cft. @ Rs. 36 per 1,000 cft.	950
4. Repairs to pitching, cunnettee etc. and providing new pitching at junctions 30,000 sft. @ Rs. 40 per % sft.	12,000
	75,950
Add 3% contingencies	2,279
	78,227
Say	78,000

ANNEXURE VI

Estimate of cost for desilting Kushak nala and Barapula nala

1. Total length of nalas considered	32950 Rft.
2. Details of cost :—	Rs.
(*a*) Earth work in excavation. (lift upto 5′) 54,00,000 Cft. @ Rs. 24 per 1,000 sft.	1,29,600
(*b*) Extra for additional lifts 50,76.500 cft @ Rs. 4/- per 1,000 cft.	20,306
(*c*) Excavation in saturated soil (lift upto 5) 1,19,000 cft. @ Rs. 74 per 1,000 cft.	8,806
(*d*) Extra for additional lifts, for saturated soil, 1,19,000 cft. @ Rs. 3 per 1,000 cft.	357
(*e*) extra for lead :—	
(*i*) 4 chains. 16,000 cft @ Rs. 8 per 1,000 cft.	128
(*ii*) 11 chains. 75,000 cft. @ 22 per 1,000 cft.	1,650
(*iii*) 6 chains. 2,10,000 cft. @ 12 per 1,000 cft.	2,520
(*iv*) 5 chains. 21,600 cft. @ 10 per 1,000 cft.	216
(*v*) Upto 3 miles. 7,43,000 cft. @ 85 per 1,000 cft.	63,155
(*f*) Repairs to pitching where these are in damaged conditions :—	
(*i*) Stone pitching. 10,000 sft. @ 34-12-0 per % sft.	3,475
(*ii*) Brick pitching. 20,000 sft. @ 25-12-0 per % sft.	5,150
(*g*) Dressing and levelling involving cutting and filling upto 6″. 21,33,300 sft. @ 5 per % sft.	10,667
	2,46,080
Add 3% contingencies	738
Cost of desilting per hundred running feet of nalla :— Rs.	2,53,411

$$\frac{2\cdot53\cdot411}{330} :: 770/-$$

ANNEXURE VII

Estimate of cost for providing pumping station for Nizamuddin and subsidiary S.W. drain for high level areas :—

1. Providing pumping station for Nizamuddin :—	
(*a*) Construction of new main drain to the pumping house :—(4000 Rft.).	
30″ dia. 936 rft. @ 33/- per rft.	30,888
36″ dia. 689 rft. @ 39·40 per rft.	27,147
45″ dia. 340 rft. @ 56·00 per rft.	19,040
51″ dia. 335 rft. @ 68/- per rft.	22,780
54″ dia. 436 rft. @ 73/- per rft.	31,828
66″ dia. 564 rft. @ 120/- per rft.	67,680
72″ dia. 700 rft. @ 119/50 per rft.	83,650
TOTAL	283,013
(*b*) Construction of sump well and pump house :—	
(*i*) Sump well. 1,02,690 cft @ Rs. 2·00 per cft.	2,05,380
(*ii*) Pump House 594 sft. @ 12 per sft.	7,128
(*c*) Purchase and installation of pumps and meters. 3 sets of 70 B.H.P each @ 26,000 each	78,000
(*d*) Provision of non return flat for existing drains discharging into Barapulla nala	1,100
(*e*) Provision of regulator on the proposed drain to the sump	8,000
	5,82,621
Add 3% contingencies	17,479
	6,00,100
2. Providing S.W. drain for the tomb area :—	
30″ dia. R.C.C. pipe 850 ft. @ Rs. 33 per rft.	28,050
36″ dia. R.C.C. pipe 400 rft. @ Rs. 39/40 per rft.	15,760
45″ dia. R.C.C. pipe 1300 rft. @ Rs. 56/00 per rft.	72,800
	1,16,610
Add 3% contingencies	3,498
Total Cost :—6,00,100+ 1,20,108 : : 7,20,208 Say 7,20,000	1,20,108

ANNEXURE VIII

PROJECT ESTIMATE FOR IMPROVEMENT OF DRAINAGE IN BLOCK NO. 1*

1. Improvement to interception arrangement in pre-1939 New Delhi area *vide* annexure I para (*d*)1	20,06,000
2. (*a*) Augmenting the capacity of main drains in pre-1939 New Delhi area *vide* annexure I para (*d*) 2	94,50,000
(*b*) Duplicate lines for drains I-C, I-E and I from K to Q point *vide* annexure I para (*d*)3	43,68,000
3. Improvement of drainage of Golf Link Colony (*vide* annexure IV)	20,000
4. Improvement of drainage of Jor Bagh (*vide* annexure III)	1,56,000
5. Providing pumping station for Nizamuddin (*vide* annexure VII)	7,20,000
6. Augmentation of outfall channel No. 3 (*vide* annexure II)	27,10,000
7. Desilting of nalas. 70,000 Rft. @ Rs. 770 per % rft. (for unit rate refer annexure VI)	5,39,000
8. Widening an resectioning of Sonehripul nala *vide* annexure V	78,000
9. Remodelling Lajpat Nagar Nala for increased capacity (based on rough details)	1,65,000
10. Remodelling of Friends Colony nala for increase capacity 10,000 Rft. @ Rs. 15 per Rft. (based on rough details)	1,50,000
11. Regrading of Kushak Nala in its upper reaches. (Estimate already submitted to Govt.)	1,86,000
12. Providing Bunds for Barapula Nala in the reach between Barapula Bridge and Ring Road Bridge. (Based on rough details)	1,50,000
13. Remodelling of Barapula Bridge and Muthra Road Bridge over the Barapula Nala. (Lumpsum)	12,00,000
14. Provision of a syphon under railway Bridge over Barapula Nala	6,00,000
15. Probable cost of remodelling road Bridge wherever necessary (Lumpsum)	10,00,000
16. Fire-Brigade relief drain (estimate already submitted to Govt.)	67,000
17. Improvements of drainage near Market Road Square (Lumpsum)	19,000
18. Improvements of drainage in Minto Road Area (Lumpsum)	20,000
19. Providing pump under Minto Road Bridge (estimate already submitted)	50,000
20. Providing pump under Hardinge Bridge (probable costs on the basis of Minto Road Bridge)	50,000
21. Improvements to Sewerage	7,00,000
TOTAL	2,44,04,000

*NOTE.—The above estimate is based on sample survey and the final cost can be worked out only after all the detailed investigations are completed. The amount worked out is exclusive of Departmental charges on account of tools and plant, establishment and supervision.

ANNEXURE IX

Phase I—Emergent Works

	Rs.
1. Desilting and sectioning of Nalas as per design	5,39,000
2. Relief drain behind Fire Brigade area	67,000
3. Remodelling of Karbala Drain to prevent flooding Jorbagh area	1,56,000
4. Providing an independent outfall for Golf Link Colony	20,000
5. Improvement to the drainage in Market Area	19,000
6. Improvement to drainage in Minto Road Quarters	20,000
7. Regrading of Kushak Nala in Upper reaches	4,86,000
8. Improvement to drainage & provision of pumps for Minto Road Bridge	50,000
9. Desilting and sectioning of Sonehripul Nala	78,000
	11,35,000
10. Improvements to Sewerage	7,00,000
TOTAL	18,35,000

Phase II—Urgent Works

	Estimated cost Rs.
1. Improvement to the interception arrangements along road and round abouts and providing open surface drains where they do not exist	20,06,000
2. Augmenting capacity of outfall channel 3 between Q point and Sonehripul Nala	27,09,000
3. Providing additional drains along Panchkuin Road, Barakhamba Road, Aurangzab Road York Road, Akbar Road, Prithvi Raj Road, Kushak Road, Chelmsford Road and Ashoka Road (19,280 Rft.)	15,68,000
4. Remodelling Muthra Road Bridge and Barapulla Bridge to give relief to heading up of water in Sonehripul Nalla, Lajpat Nagar Nalla and outfall channel No. 3	12,00,000
5. Remodelling of Lajpat Nagar Nalla	1,65,000
TOTAL	76,48,000

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APPENDIX IV

PRELIMINARY REPORT ON DRAINAGE OF NAJAFGARH AREA (DELHI STATE)

INTRODUCTION

This preliminary report on the improvement of the Najafgarh Drainage area has been prepared after an office study of Survey of India topo-sheets without any field surveys. Very scanty field survey data for the Najafgarh drain only are available, and as such the proposals put forth give a rough idea of cost involved. The report envisages the following :—

(*i*) An immediate interim relief for regrading the Najafgarh drain above the reach which has been regraded last year. This will even up the existing river bed slope and local humps, between Kakraula bridge (situated about 18 miles above the outfall of the Najafgarh drain into the Yamuna) and the Basaidarapur village road bridge (about 8 miles above the outfall of the Najafgarh drain into the Yamuna) and relieve about 2900 acres for rabi cultivation earlier than before.

(*ii*) A substantial intermediate scheme to ensure an area of about 6300 acres for rabi cultivation. This envisages widening the Najafgarh drain to 60 width and steepening the present flat-bed slope within a reach of about 13 miles below the Kakraula bridge.

(*iii*) A long term plan to afford completely relief and relieve all the inundated areas for rabi and/or kharif cultivation. This will also protect the villages which get marooned during floods.

PRELIMINARY REPORT ON DRAINAGE OF NAJAFGARH AREA (DELHI STATE)

1. Main drainage of Najafgarh block and Alipore block (in Delhi State) drains partly into Najafgarh Jheel and partly into Najafgarh drain. The area is located (*i*) Around the Najafgarh Jheel and (*ii*) Part basins of Mungeshpur and Nangloi drains in their tail reaches.

2. **Main features**

2. 1 *Najafgarh Jheel.*—The Jheel proper is a natural saurcershaped depression situated approximately at Latitude 28°-30′ and Longitude 76°-56′, near the Najafgarh village, about 20 miles southwest of Delhi City. The jheel is filled during the monsoons by its own independent catchment of about 219 sq. miles. lying partly in Delhi State and partly in Punjab State. Out of this 219 sq. miles, about 75 sq. miles consist of hilly or semi-hilly region of Gurgaon district. From the available contour urvey plans of the jheel, Area-Capacity—area submerged, curve has been prepared *vide* exhibit I. Various values are tabulated as under :

Water level	Area submerged in acres			Capacity in Acre ft.
	Delhi	Punjab	Total	
693	9700	6400	16100	57500
692	7680	5320	13000	43200
691	5480	4520	10000	33400
690	3850	3650	7500	22500
689	3100	2700	5800	15750
688	2300	2300	4600	10500
686	1450	1050	2500	3250
684	150	200	350	..

Within this catchment there are some existing irrigation reservoirs, which hold up water during monsoon for irrigation purposes and incidentally may moderate the flood runoff into the jheel. These are (*i*) an earthen storage dam at Ghata Kangarpur, (*ii*) Jharsa-Medwas and (*iii*) Wazirabad detention bunds. During the rains, after the above irrigation reservoirs are filled, surplus water flows towards Najafgarh Jheel. Just before the rabi season starts, the balance water, if any, left over in these reservoirs, is also allowed to escape and find its way into the Jheel. The jheel has only one outlet, *viz.*, the Najafgarh drain, which outfalls into the Yamuna just below Wazirabad pumping station, north of Delhi City.

2·1·1 *Rainfall pattern* .—The mean annual rainfall in the catchment works out to 16·68 inches during the 4 monsoon months of June—October. This is based on the rainfall records for the period from 1940 to 1955. For the last 3 years or so the average rainfall has indicated an increase maximum being about 37·4″ during the period June to September in 1958. Details of annual rainfall are shown at Appendix I. It is, however relevent to point out that there have been occasions in the past when the rainfall has been very scanty, resulting in serious droughts.

2·1·2 *Crop Practice* .—Areas surrounding the lake are cultivated for rabi crops. Partial irrigation is being done by a number of open wells, whose depths vary from 5 to 15 ft. During the years when rainfall is scanty, droughts conditions have been reported. Most of the lands in the area appears fit for cultivation. However, there are some isolated patches of land where some sort of reclamation is necessary. By local enquiries it has been ascertained that the maximum water level within the jheel in the recent past (except for the 1958 season) has arisen to about R. L. 690 submerging an area of about 7500 acres. Similarly in a year of average rainfall the area usually flooded is about 5800 acres, corresponding to a level of 689·0. By about the time of rabi sowing (November) the jheel water level falls to about R. L. 688·00 exposing an area of about 2900 acres for rabi crop. (Wheat and Gram, etc.). Areas below R.L. 688·00 are lost to rabi cultivation. From November till next monsoon, drop in water level is entirely through evaporation and absorption losses, as the Najafgarh drain did not formerly function when the Jheel is below R. L. 688·00. An area of about 2000 acres between R. L. 688 and R. L. 686 exposed by end of February was being used for sugarcane cultivation. During the following monsoon seasons this crop had to stand a depth of 3 to 4 ft. of water, when the water level in the tank rose to R. L. 689 or R. L. 690. Output of this crop depends upon the depth and duration of flooding. However, before the last monsoon Najafgarh drain has been desilted in certain reaches. This is expected to reduce jheel levels further from R. L. 688 to R. L. 686 earlier than before.

2·2 *Najafgarh Drain*

2.2.1 The Najafgarh drain after flowing for about 31 miles in a serpentine course flows in its tail reach through Delhi Urban areas and outfalls into the Yamuna just below the Wazirabad pumping Station. The drain is joined on the left by Mangeshpur and Nangloi drains and on the right by the Hill streams of Delhi and Punjab States *vide* exhibit I. In its reach within Delhi City area, the drain also acts as the main drainage outlet for the Daryala Nala and other City storm water drains, which carry City sewage as well.

2.2.2. The drain takes a regular section at a small distance upstream of the Chhawala bridge (R. D. 18250). Bed width of the drain varies from 55 ft. to 70 ft. between the Chhawala bridge (R.D. 18250) and Kakraula bridge (R.D. 65000). In some portions broken banks exist on both sides. Below Kakraula bridge, a well defined channel exists with banks on either sides. Between Kakraula bridge and the Basaidrapur bridge (a distance of about 13 miles) bed width varies from 70 to 40 ft. Below this, bed width varies from 30 to 40 ft. In some isolated reaches it is even 20 ft. wide.

2.2.3. A study of bed levels of the drain has revealed that from the Jheel right upto Basaidarapur village road bridge (a distance of about 22 miles) bed of the drain is practically level. There is rather a gradual reverse slope towards the jheel, the level of the jheel being R. L. 683 that of Kakraula bridge R. L. 684, and that of Basaidrapur bridge, R. L. 685. Below Basaidrapur bridge the bed has a slope of 1 in 8000 upto R. D. 133000. In the lower reach below R. D. 133000 right upto the outfall, the drain has a very good bed slope of 1 in 1250 ft. Above the confluence with the Mangeshpur drain, at R. D. 67100 regulating arrangements have been provided to the Kakraula road bridge (R.D. 65000) with a view to check the back flow from the Mangeshpur drain into the jheel (whenever the water level in the jheel is low).

2·3 *Mangeshpur Drain*

This originates in Punjab territory near village Mangeshpur and generally flows south. Near the village of Ladpur and Kanjhawala (Delhi State) it is joined by Bazidpur and Bawana drains. Below this it continues to flow south and near Bahadargarh it is joined by Westjua drain whose catchment lies entirely in the Punjab. Below Jharoda Kalan, the drain takes an easterly turn and is joined by Madanpur drain. Finally it flows in a south eastern direction and joins Najafgarh drain at R. D. 67100, about ½ mile downstream of Kakraula bridge. Its entire catchment including that of tributary drains right upto its outfall into Najafgarh drain, is about 203 sq. miles.

2·4 *Nangloi Drain*

This originates at Puthkhurd and its entire catchment area of 32 sq. miles lies in Delhi State. After passing Shahibabad-Doulatpur, it changes its course and flows south, near Sultanpur and Nangloijat. It joins Najafgarh drain at R. D. 97250 near Nangloi Saiyidan. Total length of the drain is about 12 miles.

2·5 *Hill stream of Punjab*

These drains originate at northeast of Gurgaon (Punjab). The area is almost rocky having gentle slopes. A storage reservoir and detention bunds, as referred to in para 2·1 above, are situated within this catchment. The total area of catchment upto Jharsa-Medwas bund is 50 sq. miles and is included within the total catchment of the Jheel.

2·6 *Other Hill stream of Delhi State*

These originate on the south of Delhi City and have a total catchment area of about 75 sq. miles. During monsoons, water of these streams flow into jheel through Najafgarh drain. Most of the area is rocky. Palam drain which forms part of the catchment has a sub-catchment of 4·8 sq. miles of built-up area and joins the Najafgarh drain at R. D. 22000.

2·7 *Daryala Nallah*

This drains Delhi City in an area of about 4·6 sq. miles. Its present discharge capacity is reported to be insufficient due to which there is flooding during times of heavy rainfall. This nala joins Najafgarh drain just above Subzimandi-Wazirabad road bridge at R. D. 134000.

2·8 *Other City Drainages*

The catchment area works out to about 3·8 sq. miles of built-up area.

3. *The Problem*

3·1. The Najafgarh Jheel which acts as a natural drainage reservoir for the surrounding lands permits cultivation of areas on its fringes during the years when rainfall is not heavy. During heavy rainfall, the lake is not able to discharge its flood waters unless the Jheel level rises above R. L. 685.

3.2. Even when the Jheel level rises above R. L. 686, the maximum flood flow into the jheel is not expeditiously drained by the Najafgarh drain, because of its very limited discharging capacity.

3.3. Because of the existing reverse slope of the Najafgarh drain upto Basaidrapur village road bridge, as referred to in para 2.2.3 whenever the Mangeshpur, Palam and other hill streams of Delhi and Punjab area are in floods, their waters are carried towards the Jheel instead of towards the outfall into the Yamuna, thus aggravating the drainage problem further.

3·4 In addition, there is inundation in the basins of the Mangeshpur and Nangloi Drains lying within the State of Delhi partly due to their own limited discharging capacities and partly by their poor outfall conditions in the Najafgarh drain.

4. Effect of the Heavy Rainfall of 1958 on the Drainage areas

During the last monsoons, Delhi area has experienced an unprecedented rainfall which was about 37·4 inches during the monsoon months. The water levels attained in the Jheel from 26th July 1958 were observed and are enclosed in the graph *vide* exhibit 3. From the graph it is seen that water level of the jheel after 23rd August 1958 was higher than that of water level under Chhawla and Kakraula bridges. Also water level of the Chhawala bridge during this period was higher than that under Kakraula bridge. It is, therefore, apparent that there was no back water contribution from the Najafgarh Jheel, and that the rise in Najafgarh jheel was entirely due to other catchments draining into the jheel above the Chhawala bridge. During the period from 29th September and 1st October, *i.e.*, a period of 2 days, the water level in the Jheel rose from R.L. 690·3 to R.L. 691·8, *i.e.*, a rise of 1·5 ft. which corresponds to a gross inflow of about 14,600 acre ft. The maximum level of the jheel attained on 9-10-58 was 692.4 submerging an area of about 14,400 acres. This has been reported to be the maximum rise for many years. Local enquiries in Gurgaon districts have revealed that this sudden inflow of flood waters in the lake was due to a breach in the Jharsa-Medwas bund on 29th night. Had this bund not breached, it is possible that such high levels might not have been attained. After this, the maximum level of the jheel water has been falling and was reported to be at R.L. 691·5 on 1st November 1958. During this period average discharge of the Najafgarh drain has been estimated to be of the order of about 180 cusecs, which is not adequate. On account of the above, it has not been possible to cultivate the land for rabi cultivation during the current year. The previous sugarcane crop continues to be submerged in about 3 to 5 ft. of water, and has, therefore, suffered quantitatively and qualitatively. It is expected that the present water level in the jheel will fall further partly due to discharge of the Najafgarh drain and partly through absorption and evaporation losses and that about 3000 to 4000 acres will appear for next sugarcane cultivation by February-March.

5. History and measures taken in the past

As far as it is known, most of the drains joining Najafgarh drain on the left which add to the drainage problem of the Najafgarh area, were constructed by the Punjab Irrigation Department as part of their canal system to prevent water logging due to the canals. Najafgarh drain itself is known to have been handed over by Punjab Government to Delhi Administration sometimes towards the end of the last century, and since then no maintenance or desilting works appear to have been undertaken till 1957. Some field surveys of the Najafgarh drain were carried out by Central Water and Power Commission in 1956. These surveys revealed that the width of the nala had considerably reduced due to silting and humps had been formed in the reach upstream of R.D. 1,23,000, which prevented to a great extent, efficient drainage of Jheel waters. A scheme amounting to Rs. 4 lakhs for regrading the Najafgarh drain within the above reach was prepared and submitted by the Central Water and Power Commission sometime in early 1957. The scheme envisaged drainage relief to about 1,600 acres of land for rabi cultivation by about end of November. Work on this scheme was started by C.P.W.D. in 1957-58, and is reported to be completed, except for some stone pitching work.

6. Available Survey Data

Following data is available :—

(*i*) Longitudinal Sections and some cross-sections of Najafgarh drain for entire length taken during 1956.

(*ii*) Fresh surveys of Najafgarh drain completed in 1958 for a reach of 2 miles above the outfall.

(*iii*) 4″ to 1 Mile contour surveys at 1 foot interval prepared in connection with investigations for Bakra Project, Punjab, which covers a part catchment of the Najafgarh Jheel.

(*iv*) Longitudinal sections of Mangeshpur and Nangloi drains.

No further hydrologic or hydraulic data for the Najafgarh jheel and various inflow streams is available. Information on areas inundated annually together with figures of direct and indirect annual damage are also not available.

7. Lines suggested for solution of the drainage problem

A satisfactory solution of the drainage problem would obviously be to get rid of the flood waters as expeditiously as possible so as to make available maximum possible areas for rabi/kharif or perennial crops, and thereby also give complete relief to the marooned villages. The basic engineering solution to achieve this object will appear to lie in increasing discharge capacity of the Najafgarh drain as much as possible, within the physical and economical limits. *Prima facie* it appears that the availability of the land within the Delhi urban areas for resectioning the Najafgarh drain will decide the degree of relief that can ultimately be achieved.

7·2 The present report has been formed on the basis of a very scanty field data, and firm estimates and conclusions can only be arrived at after detailed field surveys are made. After an office study of topo-sheets and other old surveys, following 3 proposals are put forth.

(*i*) An immediate interim relief by regrading the Najafgarh drain above the reach which has been improved during the last year.

This will even up the existing reverse bed slope and local humps between Kakraula bridge and the Basaidrapur village road bridge and relieve about 2,900 acres for rabi cultivation, earlier than before.

(*ii*) A substantial intermediate scheme to ensure an area of about 6,300 acres for rabi cultivation.

(*iii*) A long term plan to afford complete relief, and relieve all the inundated areas for rabi and/or kharif cultivation. This will also protect any villages which get marooned during floods.

These proposals are detailed in the subsequent paragraphs.

7·2·1 The immediate measure proposed is recommended to be completed before the next monsoons, so as to relieve about 2,900 acres for rabi cultivation earlier than before below the jheel level of R.L. 690. This envisages removal of humps, and regrading bed of the Najafgarh drain within a reach of about 10 miles from Kakraula bridge (situated about 18 miles above the outfall into Yamuna) to about 2000 ft. below the Basaidrapur road bridge (about 8 miles from the Yamuna outfalls) and desilting etc. of the Mangeshpur and Nangloi drains *vide* exhibit 5. Existing masonry structure within this reach will not require to be replaced. Below this reach, as already stated, regrading work has already been done during the preceding year. The estimated cost of this proposal is about Rs. 2·7 lakhs.

7·2·2 Substantial relief can be given by increasing the discharging capacity of the Najafgarh drain so as to relieve about 6,300 acres in the Jheel below R.L. 690 and ensure rabi cultivation thereof. This envisages resectioning of the Najafgarh drain from R. D. 65,000 (Kakraula bridge) to R.D. 1,38,000 *vide* exhibit 6. It is proposed to widen the drain to a bed width of 60 ft. and steepen the bed gradient to 1 in 10,000. In this case it will however be necessary to lower the bed by about 4 ft. under the existing masonry structures. Railway authorities have since informed that it will not be possible to permit lowering of the existing nallah bed under the railway bridges without reconstructing them. Similar information on the remaining intervening structures is not forthcoming, but it may be presumed that these will also require replacement. Accordingly, the cost of the proposal is worked out to approximately Rs. 25·93 lakhs which includes cost of replacement of the masonry structures. The immediate measure proposed in para 7·2·1 above will be dovetailed in the present proposals.

7·2·3 As regards a complete long term plan, a tentative scheme has been worked out after an office study of topo-sheets. This will relieve an area of about 14,800 acres around the Jheel and other inundated areas from 10,000 to 15,000 acres within the basin of other inflow drains during abnormal rainfall season like that of 1958. During the years of normal heavy rainfall the area protected will be about 7,500 acres. The area thus protected can be used for kharif and/or rabi cultivation. The proposals, as worked out, envisage the following :—

(*i*) Providing a catch water drain around the jheel between contours 694—690 so as to intercept a catchment of about 180 sq. miles out of a total of 219 sq. miles.

(*ii*) Providing a suitable detention basin on the Palam drain so as to regulate its calculated maximum flow of 2,080 cusecs to about 250 cusecs. The tail reach of this drain is proposed to be diverted to join the Najafgarh drain below its existing confluence.

(*iii*) Regrading and/or diversion of :—

(*a*) Mangeshpur drain.
(*b*) Nangloi drain
(*c*) West Jua drain

to carry design discharge.

(*iv*) Diversion and draining of various hillstreams within Delhi and Punjab States directly into Najafgarh drain below Kakraula bridge.

(*v*) Regrading Najafgarh drain from R.D. 65,000 (Kakraula bridge) till its outfall into the Yamuna to cater for increased discharges from the Mangeshpur, West Jua, Nangloi drains, hillstreams, Palam drain and other city drainages.

In case it is not possible to moderate maximum discharge of the Palam drain envisaged in sub-para 7·2·3(*ii*) above, it will not be possible to drain its regulated discharge through Najafgarh drain without increasing the latter's capacity further.

There are various alternatives to drain the storm waters. Works under item 7·2·3 (i) and (ii) above are necessary components in all the alternatives. The various alternatives will be :—

(*a*) (*i*) Regrading and diversion of Mangeshpur and Nangloi joining Najafgarh drain below the Delhi Distributary at R.L. 1,33,000.

(*ii*) Diversion of hillstream to join Najafgarh drain below Basaidrapur bridges

(*b*) (*i*) Regrading of Mangeshpur and Nangloi as at (*a*) (*i*) above.
(*ii*) Diversion of hillstream as at (*b*) (*ii*) above.

(*c*) (*i*) Regrading and diversion as mentioned above (*b*) (*i*).
(*ii*) Drainage of hillstream as at (*a*) (*ii*) above.

The cost of the proposals under the above alternatives approximately more or less to Rs. 150 lakhs. A very rough general abstract of the cost for alternative (a) is indicated in Appendix 3 and details of plan are shown *vide* exhibit No. 2. *Inter se* superiority of various alternatives and exact benefit cost ratio can only be decided after detailed field surveys.

8. Phasing of works under various proposals

8.1 Detailed field surveys for preparation of firm estimates for the immediate relief as envisaged in para 3.2 above may be undertaken forthwith and the work of regrading started by March 1959 and completed within the next three to four months.

8.2 During the present season investigations and preparation of firm estimates for interim relief as envisaged in para 3·3 above, may also be undertaken and completed. Proceedings for acquiring necessary land widths and other formalities regarding construction of the existing masonry structures may be completed during the present working season. During the 1959-60 working season reconstruction of masonry works may be completed, possession of land taken, and some work in regrading of Najafgarh drain may also be commenced. Remaining earth work in the drain may be completed within the working season of 1960-61.

8.3 Field investigations for preparation of detailed estimates for the complete relief as envisaged in para 7.2.3 above, may also be started and completed during the current working season.

9. Hydrology

9.1 Maximum flood discharge from various catchments has been worked out for the purpose of design and shown at Appendix II. In case where information on catchment area is not available, the same has been roughly worked out from the topo-sheets. A note on the runoff calculations is given at Appendix VI.

9.2 The area enclosed within the proposed catch water drain as envisaged in the complete plan *vide* para 7.2.3 above is about 50 sq. miles. The average run off during the months of June—October has been worked out on the basis of Strange's Method for an average catchment *vide* Appendix IV. The water level attained in the jheel are worked out in Appendix V. By the end of November, about 500 Acre ft. of water are expected to remain in the jheel which can be utilised for irrigation purposes.

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APPENDIX I

RAINFALL IN NAJAFGARH JHIL CATCHMENT

Catchment Area 219 Sq. Miles

Year	Rainfall in inches
1940	15·70
1941	12·42
1942	25·32
1943	18·36
1944	17·97
1945	19·46
1946	15·81
1948	14·38
1950	18·57
1951	7·02
1952	13·72
1953	16·87
1954	17·84
1955	20·15
Total of 14 Years	233·59
Average of 14 Years	16·68

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APPENDIX II

DESIGN DATA FOR VARIOUS INFLOW STREAMS/CATCHMENT AREAS DRAINING INTO THE NAJAFGARH DRAIN OR INTO THE JHEEL

Sl. No.	Name of the drain	Catchment area as measured from the maps or intimated by other departments Sq. Miles	Existing discharging capacity (Cusecs)	Designed Discharge per Sq. Mile (Cusecs)	Discharge Total Discharge (Cusecs)	Remarks
1.	Hill Streams of Punjab	50	NA	+	1500	+The catchment area is partly gentle sloping hilly and partly plain area. The runoff in the gentle sloping hilly tract is taken as 20 cusecs per sq. mile and that of plain area as 10 cusecs per sq. mile. Out of 110 Sq. miles 40 Sq. miles is hilly and 70 plain. Runoff 10 × 20 +70 × 10 = 1500.
2.	Hill Streams of Delhi	50	NA			
3.	Catchment of Jheel within catch drain and ring bund.	50	NA	10	..	This will flow in the Najafgarh drain.
4.	Other catchment of the jheel.	100	NA	5	500	The catchment is sandy.
5.	Palam drain . .	4·8	..	..	2080	The discharge is worked out at ½" per hour nett run off.
6.	Mangeshpur drain .	102	100	10	1020	
7.	West Jua drain . .	101	234	5*	505	*Verbally informed by S.E., Western Jamuna Canal (East) Circle.
8.	Nangloi drain . .	32	44	10	320	
9.	Daryala Nalla . .	4·6	..	..	2834	Figures given by Drainage Dn. C.P.W.D.
10.	Other City drainages .	3·8	..	..	2800	Worked out on the basis of 9 above.

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APPENDIX III

ABSTRACT OF COST OF DRAINAGE SYSTEM OF NAJAFGARH

Details	Cost in lakhs
1. Diversion of Hill-stream	14·10
2. Diversion of Mungeshpur drain	28·60
3. Regrading of Mungeshpur drain	12·07
4. Regrading of Nangloi drains	2·67
5. Regrading of Najafgarh drain	46·00
6. Providing catch drain and ring bund around the Najafgarh Jheel and drain	7·00
7. Construction of Bijwason Bund	5·97
8. Constructing link flood channel between Jhirsa and Bijasen bunds	2·50
9. Providing link channels (5 Nos. at Rs. 20,000 each)	1·00
10. Strengthening of Jharsa Midwas Bund	2·00
11. Detention bund on the Palam drain	1·00
12. Najafgarh drain new cut near Shah Alam bridge	5·00
13. Q. Special Tools & Plant	22·00
Q1. Resale of Special Tools & Plants	(—)14·00
TOTAL	138·91
New supply of Tools & Plant 1% of total under B-Land	1·09
TOTAL	137·82
Establishment charge at 8 1/3%	11·5
TOTAL	149·32
Say Rs.	150 lakhs

APPENDIX IV

RUNOFF FROM NAJAFGARH JHEEL BOUND BY THE CATCH WATER DRAIN

Area 50 sq. miles
Average Catchment.

Year	June	July Ac/ft.	August Ac/ft.	September Ac/ft.	October Ac/ft.
1940	..	537	2660	..	..
1941	..	..	266	107	266
1942	..	1470	120	5050	..
1943	..	..	800	3720	..
1944	..	1070	1070	1610	810
1945	..	..	535	4800	..
1946	..	480	2190	535	..
1948	..	..	1330	800	266
1950	..	..	1610	3200	..
1951	..	..	..	..	..
1952	..	..	2130	..	..
1953	..	610	1860	266	266
1954	..	266	239	670	..
1955	..	..	1610	2930	1330
TOTAL	..	4433	20420	23688	3473
Average of 14 years		316 A/Ft.	1458 A/Ft.	1692·0 A/Ft.	248A/Ft.

APPENDIX V

STATEMENT SHOWING LEVELS WITHIN THE AREA ENCLOSED BY CATCH DRAIN

S. No.	Month	Water in the Jhil at the beginning of the month. (Acre ft.)	Run-off from 50 sq. miles during the month (Acre ft.)	Total water in Jhil during the month (Acre ft.)	Water level attained during the month (Acre ft.)	Absorption evaporation losses during the month (in ft.)	Water level at the end of the month	Water at the end of the month (Acre ft.)
1	2	3	4	5	6	7	8	9
1.	July . . .	Nil	316	316	684·3	0·33	684·0	Nil
2.	August . .	Nil	1458	1458	685·2	0·25	684·95	750
3.	September . .	800	1692	2492	685·70	0·33	685·37	1850
4.	October . .	1850	248	2098	685·5	0·5	685	1000
5.	November . .	1600	..	100	685	0·42	684·58	590

APPENDIX VI

Note on the Basis of Runoff for Draining Rural Areas of Delhi

Rainfall

As Palam rainfalls are readily available, these were taken to represent the rainfalls of rural areas of Delhi. Frequency studies were carried out by the method of partial duration series to find out the maximum 3 days' rainfall for a return period of 5 years and 10 years respectively. The maximum 3 days' rainfall occurring once in 5 years is 8·2 inches and once in 10 years is 9·6 inches.

The existing Jharsa Medwas Bund near Gurgaon intercepts all the drainage of the partly hilly and partly plain country to the east of the Gurgaon Badshahpur Road. The contour map of the depression, as well as, the sufficient water levels at these bunds were available for 1958 to estimate the runoff from this area during August and September, 1958. Correlating runoff with the corresponding rainfall it is found that runoff factor for this area of the order of 30%. The same co-efficient of runoff was assumed for similar hilly area draining into the Najafgarh Jheel.

The factor for plain area may be taken as 50% of this which gives 15% runoff. This also is well within the range recommended by the Technical Committee for open spaces.

It is considered advisable to design the drainage so as not to allow water to stand in this area for more than 3 days; hence the 3 days' runoff has to be drained within that same period. To design for the worst condition occurring once in 5 years the runoff per sq. mile from the flat country round the Jheel will be equal to $\frac{8\cdot2}{12} \times \frac{640}{2\times3} \times \frac{15}{100} = 10\cdot8$ cusecs, say 10 cusecs.

S.E., Western Yamuna Canal, had carried out actual discharge observations of the various drains in this area during this year's rains. The table below gives the observed date. Discharge per sq. mile is given in the last column No. 6. It will be seen therefore that this figure varies from 2 to 9·8 cusecs per sq. mile. Hence the assumption of 10 cusecs runoff per sq. mile for the plain area appears reasonable.

Statement showing the observed data of drains in Delhi Sub-Division of Delhi Division during the flood season 1958.

S. No.	Name of Drain	Designed discharge	Actual discharge	Catchment area	Discharge per sq. mile
1.	Nangloi drain	44 cs.	149 cs.	32 sq. mile	4·6 cs. per sq. mile
2.	Mangeshpur drain . . .	100	804	82	9·8
3.	Madanpur drain	20	94	20	5·7
4.	Bawana drain	17	61	10	6·1
5.	Bazidpur drain	29	45	20	2·25
6.	West Jua drain	234	221	101	2·2
7.	Khanda drain	65.	136	35	3·9
8.	Bhudana drain	15	63	11	5·7
9.	East Jua drain	65	136	35	3·9
10.	Drain No. 6	191	115	130	·88
11.	Mahra drain	22·4	78	19	4·1

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It has to be remembered that the design of the drain will depend on the degree of relief that is desired to be given to the distressed area. In this locality it is not considered advisable to limit the relief to less than what has been suggested in the above note. Moreover, the cultivated area under consideration is likely to develop partially at a comparatively rapid rate than cultivated areas in other localities. This would also have the effect of increasing the runoffs in future. Under the circumstances, a reduction in the co-efficient suggested will not be desirable.

EXHIBITS

1. Site Plan of Najafgarh Drainage system 1″=4 miles.
2. Map of Delhi State 1 mile.
3. Water observations of Najafgarh drain and Jheel.
4. Area capacity curve.
5. L—Section of Najafgarh Drain—Immediate Interim relief.
6. L—Section of Najafgarh Drain—Substential Interim Scheme.
7. L—Section of Najafgarh Drain—Complete relief.
8. L—Section of Bund No. 1.
9. L—Section of Bund No. 2.
10. L—Section of Mangeshpur Drain upto new cut.
11. L—Section of Mangeshpur Drain—Proposed new cut.
12. L—Section of Mangeshpur Drain below proposed new cut.
13. L—Section of Hill-Stream drain.

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APPENDIX V

MUNICIPAL CORPORATION OF DELHI

REPORT ON STORMWATER DRAINAGE OF BLOCKS III & IV

Plan for Sewerage and Drainage of Delhi

Scope of the present plan.—The preparation of a plan for Drainage and Sewerage for the area falling under the jurisdiction of the Corporation is a stupendous task and will require much time and effort. What is aimed at now is to present a rough outline of such works for the city proper and outlying colonies such as Lajpat Nagar, Kalkaji, Hauzkhas, Greenpark, New Delhi South Extension, Pinjrapole, Okhla etc. Consideration has also to be given to the area on the left of river, such as Shahdara, Gandhi Nagar, Geeta Colony etc. The scope of the present plan is, therefore, restricted to these areas only and does not take account of the numerous outlying villages, which will be independently dealt with under the rural Sanitation and Water Supply Schemes.

City area Inadequacy of the existing sewerage system:—The sewerage system of the city was designed about two decades back for the then population and water supply. Since then both the population and water supply have undergone a phenomenal increase particularly after the partition of the Country and the subsequent refugee population added to the City after 1947. The figures below show the rise in population and water supply during the last twenty five years.

Year	*Population* Lacs.	*Water Supply* m.g.d.
1931	3·4	9·00
1941	6·8	16·50
1951	14·50	40·00
1958	19·00	58·00

Due to the increase in the population and water supply the basis on which the sewerage system was designed has undergone a material change. The sewers are very much overloaded as they have to carry a much bigger load than the capacity for which they were originally designed. A number of overflow connections from sewers into storm water drains to relieve the load on the former had to be constructed. Through these overflow connections, sewage without any treatment is being discharged into the river, for the last many years, constituting a substantial source of positive contamination to the river Jamuna which is at present the only source of drinking water for the City. The points at which sewage is allowed to discharge into the river are shown in para 6 page 7. The discharge of crude sewage into the river takes place between the two intakes of drinking water, one at Wazirabad and the other at Okhla. It is estimated that about 30 to 40 million gallons of sewage finds its way into the river per day. The danger of pollution is aggravated during the hot months of May and June when the flow in the river drops down to about 200 cusecs. The situation got out of control in 1955, when a severe epidemic of Jaundice broke out taking a heavy toll of human life and causing sufferings to hundreds of inhabitants of the city.

City divided in zones on the basis of topography.—From the study of the topography of the city, the presence of two ridge line-North South and East West and the river Jamuna on the East, the city area can be divided into four independent zones for the purpose of "Drainage and Sewerage." These Zones are :

I North Zone.

II South East Zone.

III West Zone.

IV Shahdara Zone. (including Ghandi Nagar, Geeta Colony etc.).

Miscellaneous problems.—There are other problems closely connected with the drainage of the Zones mentioned above. The chief among these is the existence of a mumber of open storm drains, some of these carrying sewage and sullage in addition to storm water. The seggregation of sewage from these drains is a far reaching problem depending mainly on the conclusion of works outlined under this plan. Some of the drains passing through the developed localities of the city should be covered as they are unsightly and some times dangerous.

This is discussed under 'V' covering of Open drains in the city.

The figures of cost mentioned in this note are based on block estimates and are liable to vary when detailed plans and estimates are prepared on the basis of an extensive survey already undertaken.

They are also likely to vary with the rise or fall in the cost of labour and materials as compared to the present market rates on which the estimates are based.

I—NORTH ZONE

1. *Topography of the area.*—This comprises of an area of about 14,000 acres, with a central valley line along the Najafgarh drain falling towards the river. The area on the right of this valley line sharply rises towards the North-South ridge line, while that on the left is mostly plain, gently sloping towards the Najafgarh drain. This zone *inter alia* includes Model Town, Azadpur Colony, Kingsway Camp, University area, Subzimandi, Karol Bagh and part of Rajinder Nagar. A large area towards the Coronation Pillar measuring about 3500 acres is saucer shaped and remains water logged for a major part of the year.

2. *Sewerage.*—The area on the right of valley line *viz.* Shakti Nagar, University area etc., is mostly sewered except for some portion abutting the Mall Road, while the area on the left has no integrated sewerage system, though some of the colonies such as Rana Pratap Bagh, Model Town, Rehabilitation colony etc. have individual sewerage system for their own colonies. Sewage from these areas is disposed of in septic tanks and Soakage pits or discharged into the Najafgarh Drain without any treatment. The sewered area (on the right of the Najafgarh Drain) is served by 3 Pumping Stations.

3. *Pumping Stations.*

1. Andha Mogal Pumping Station
2. Subzimandi Pumping Station
3. University Pumping Station

These collect sewage from their individual areas and pump it across the ridge line about 70 feet high into the main sewers of the South-East Zone and is ultimately carried for treatment to Okhla Sewage Treatment Plan about 12 miles away. A new Pumping Station on the other side of the drain at its tail end near the river has been constructed in the year 1957. It picks up sewage from Najafgarh drain and pumps it through a two miles length of C.I. rising main into the North side Plant, which has been recently constructed and put into operation in 1957. Along with sewage a considerable quantity of storm water is also pumped.

4. *Purification Plant.*—The plant deals with a flow of sewage of 20 million gallons per day. Additions to the plant are also in progress. These essentially consist of units for Secondary Treatment on Biofiltration System for 10 million gallons a day only. Works for the remining 10 million gallons may have to be carried out in future as the effluent after being used for irrigation is discharged near the water intakes at Wazirabad.

5. *Main Sewer.*—The main sewer for this Zone is under construction. This sewer will start from the Kalka Ambala Railway, follow the alignment of the Najafgarh Drain and will empty its contents into the new Pumping Station mentioned in para 3 page 3 above. The sewer will pick up sewage here before discharging into the Najafgarh Drain. On its completion the three pumping stations *viz.* Andha Mogal, Subzimandi and University will be rendered unnecessary as the flow draining to them will be diverted to the main sewer by gravity. The scope of this sewer will have however to be extended from Kalka Ambala Railway towards the west upto Old Rohtak Road, a length of about 10,000 ft.

6. *Branch Sewers.*—A large number of branch sewers have to be laid in the area commanded by this sewer. This area admeasures about 1,500 acres and includes Radio Colony, T.B. Hospital, Harijan Colony, Parade Road, Kingsway Camp, Vijay Nagar, Rehabilitation Colonies, Ranapratap Bagh etc., on the left and an area adjacent to Mall Road admeasuring about 300 acres on the right. In selecting the areas for laying branch sewers, the main consideration is to provide sewerage facilities to colonies private or Government, and to such of the areas which are earmarked under the development programme during the next five years for development (*vide* Appendix 'B').

7. *Storm Water Drainage.*—A subsidiary Storm Water Drain has been recently constructed to serve the saucer shape area of 3500 acres mentioned in para (1) page 3 from the Model Town upto the Najafgarh Drain. This does not function when the river rises in spate and the water level in the Najafgarh Drain high. In order to keep this area dry, it will necessary to provide a battery of high capacity low head pumps and flood gates near Shah Alam Bridge or upstream near the Dhaka Village on Kingsway Road and pump out the water down stream the channel to prevent water-logging in the area in upper reaches.

8. *Cost of works in progress or completed.*—Cost of works in progress or completed during the last two years of the Second Plan period is 120·50 lacs as shown in the Appendix 'A'.

9. *Works to be carried out in next four year.*—

SEWERAGE :

		Rs. (Lacs.)
1.	Extension of sewer from the Kalka Ambala Railway upto Old Rohtak Road along Najafgarh Drain L = 10,000 Ft.	10·00
2.	Branch and tributory sewers draining into the Main sewer in (para 5) area 1500 acres. (page 4)	35·00
3.	Gas Utilization Works :	
	(*a*) Gas holder	4·00
	(*b*) Distribution piping	2·00
4.	Additional Units for Secondary Treatment of 10 m.g.d.	30·00
	TOTAL	81·00

DRAINAGE :

1.	Storm water pumps and pump-house	6·00
2.	Flood gates	3·00
3.	Improvement of Storm Water Drains	1·00
	TOTAL	10·00
	TOTAL COST	91·00

II—SOUTH EAST ZONE

1. *Topography of the area.*—This comprises of an area of about 30,000 acres and includes Civil Lines, Old Delhi Area, New Delhi-Transferred Areas and number of outlying colonies such as Hauz Khas, Kailash, Greater Kailash, Green Park, Kalkaji, Lajpat Nagar etc.

This zone is triangular in shape, sandwiched between North South ridge-line on one side and the river Jamuna on the other side. The natural topography indicates that the whole area slopes towards the river.

2. *Sewerage.—Main Sewers:* Two main sewers, running North-South serving almost the whole area exist and are connected to the main pumping station at Kilokri. The third main sewer, which is also connected to the Kilokri Pumping Station, serves the area at the base of the triangle such as Vinay Nagar, Lajpat Nagar, Jangpura, Nizamuddin etc.

3. *Pumping Stations.*—There are 12 pumping stations listed below:

1. Lodi Road Pumping Station.
2. Jangpura Pumping Station.
3. Stadium Pumping Station.
4. Aerodrome Pumping Station.
5. Shan Nagar Pumping Station.
6. Sunder Nagr Pumping Station.
7. Aliganj Pumping Station.
8. Nigambodh Pumping Station (Newly constructed).
9. Kilokri Pumping Station.
10. Ring Road Pumping Station (Under construction).
11. Power House Pumping Station.
12. Minto Bridge (storm water) Pumping Station.

Pumping Stations (items 1 to 7) seems to have been constructed, because of existing shallow depth of the main sewers. Sewage has to be pumped twice once at these subsidiary pumping stations and again at the main pumping station at Kilokri before it reaches purification works at Okhla.

4. *Purification works.*—Sewage from this Zone is drained to the Kilokri Pumping Station and pumped there from through a high level gravitation sewer to Okhla Purification Works. This plant has been functioning since 1936 on activeted sludge process (surface aeration). Its capacity is 18 million gallons per day and has been continuously working since then. Its machinery is overdue for renewal. Another plant on Bio-filteration system has been recently constructed to deal with a flow of 6 million gallons of sewage per day. The purified effluent from these two plants is allowed to flow into the river. The plant is surrounded by a large tracts of irrigable land and about 3,000 acres are being irrigated fetching an annual revenue of about a lakh of rupees, by partially purified sewage for which an additional sedimentation tank with a capacity of 12 mgd. has been recently added. The total capacity of the plant is 36 mgd. (24 mgd. complete treatment and partial treatment for 12 mgd.). Additional works for primary treatment and sludge digestion are being constructed to deal with a flow of 30 mgd.

5. *Main problems.*—The main problems in this Zone are :

1. Stopping of overflow connections from sewers into the river.
2. Prevention of aerial and fly nuisance.
3. Elimination of subsidiary pumping station.
4. Preservation of fish life in the river.
5. Segregation of storm water and sewage in the combined system of sewerage in Old Delhi.
6. Provision of sewerage facilities for outlying colonies.

These problems and the solutions recommended are described below:

6. *Stopping of overflow connection into the river.*—There are 13 overflow connections rying crude sewage from overloaded sewers into the river. These are :

1. Najafgarh Nala
2. Sweepers' Colony near Chandrawal No. 2
3. Khyber Pass Colony
4. Dhobighat Colony
5. South of Metcalf House
6. Wall Street
7. From Morigate Sewer
8. Delhi Gate
9. Rajghat
10. Hardinge Bridge
11. Princess Park
12. Purana Kila
13. Barapula Nalla (Nizamuddin)

Two of these at Wall Street and Metcalf House (Items 5 and 6) have stopped functioning due to the construction of the pumping station at Nigambodh in 1956. The overflow at Delhi Gate (Item 8) has also been stopped as a result of adjustments and manipulation in the working of the existing sewers. Numbers 2 to 4 are very small and sewage therefrom can be diverted into one or other of the nearby sewers or can be disposed of in septic tanks. The contamination due to the Najafgarh Nalla (item 1 has been substantially checked by the construction of the pumping station thereat and the North Plant, where the sewage in the nalla is pumped and purified at the plant. This source of contamination will be entirely eliminated on the completion of the North Sewer now under construction. The remaining over-flows (items 7 and 9 to 13) will stop on the completion of the following works:

1. Construction of Delhi Gate-Ring Road Sewer.
2. Pumping Station at Ring Road.
3. Rising Main from Ring Road to High Level Gravitation Duct.
4. Construction of High Level Gravitation Duct.
5. Extension of the purification plant at Okhla.
6. Extension of the Trunk Sewer from Delhi Gate upto the Red Fort.

Works under Items 1, 2, 3 and 5 are in progress and are likely to be completed in about 12 to 15 months while that under item 4 is completed. Work under item 6 will be taken in hand next year.

7. *Prevention of aerial and fly nuisance at Okhla.*—A considerable aerial nuisance due to foul gases is being experienced at and in the surrounding area of the Okhla Purification Works. The nuisance is due to the digestion of crude sludge from sewage in open earthen tanks known as lagoons. The putrefection of this sludge and the resultant omission of gases such as Hydrogen Sulphide and Carbon Monoxide permeates the atmosphere at and around the plant. Digestion of sludge in open lagoons does not permit to use the methane gas (which is one of the bye-products of the digestion of sludge) for useful purposes. Fly nuisance is also rampant. Recently five digestion tanks have been constructed and put into operation. This has considerably checked the nuisance due to foul gases and also the fly nuisance as most of the sludge is now digested in covered digestion tanks instead of in the open lagoons. The gases are collected in Gas Holders and are being converted into electric energy by generator sets coupled with gas engines. The entire needs of the Plant are satisfied by the electricity generated through gas engines.

Additional digestion tanks as a part of the extension scheme are under construction and after its completion no drying of sludge in open lagoons will be permitted.

8. *Elimination of Subsidiary pumping station.*—Pumping Stations under items 1 to 7 (para 3) are only intended to deal with sewage from individual pockets not amenable to flow by gravity into the main sewers due to shallow depth of the latter. Sewage from such pockets is collected and pumped into the main sewers draining to Kilokri where it is again pumped before it reaches the purification plant at Okhla. The double pumping entails considerable recurring expenditure. This state of thing can be considerable improved by connecting the low lying pockets to new main sewer now under construction (Delhi Gate-Ring Road), as its level is deeper by 20 feet than the existing main sewers. A detailed investigation has been undertaken to ascertain the exact nature of works to be carried out and the expenditure to be incurred on this item can only be known after the necessary data is collected.

9. *Preservation of fish and acquatic life.*—Number of complaints have recently been received about the fish life in the river being destroyed. This is due to the discharge of excess sewage received at the Okhla Plant and also through the number of overflow connections discharged into the river. With the completion of the measures outlined in para 6 page 7 the discharge of crude sewage will be totally stopped. Addition of units for secondry treatment to the extension plant now in progress is also considered necessary. Plans and estimates are being prepared and a token provision made in the next year's budget.

10. *Segregation of sewers and storm water.*—The Old Delhi area admeasuring about 5 sq. miles with a population of about ten lacs is highly congested. It is served on combined drainage system *i.e.* sewage and storm water flowing through common conduits. Due to the very narrow lanes and byelanes, a whole-sale introduction of a separate sewerage system is not possible. At present most of the houses are on dry system and waste water from privies, kitchens and bath rooms, as also the rain water is allowed to flow through narrow open drains in the gallies and ultimately joins the underground sewers at the end of the lanes. An improvement can be made by deepening the narrow open drains and covering them so that the waste water and sullage can flow through the covered drains and the rain water will flow along the open surface drains for being tapped into independent storm water drains to be newly constructed and connected to the river instead of being pumped to Okhla Plant. Before this system is adopted on whole scale, it will be tried in a small area and the results watched. The load on the existing sewerage system will be considerably reduced if measures for the segretation of sewage from storm water succeed. It will be further reduced by the diversion of the sewage now draining into the existing sewerage system by the 3 pumping stations (Andha Mogal, Subzimandi and University) to the North side plant *via* North Sewer. A substantial improvement is also expected when the work on cross connections between the existing main sewers and the new main sewer is completed.

11. *Cost of works in progress or completed.*—The cost of works in progress or completed during last two years is Rs. 266·56 lakhs *vide* Appendix 'A'.

12. *Cost of works to be carried out in next four years.*—

SEWERAGE :

		Rs. in lakhs.
1.	Extension of Trunk Sewer from Delhi Gate to Red Fort	7·00
2.	Cross connection between Old and New Sewers :	
	(*i*) Near Red Fort (*ii*) At Delhi Gate (*iii*) At Supreme Court (*iv*) Along Barapula Nala	25·00
3.	Outfall sewer from Kalkaji	5·00
4.	Sewers in Kotla Mubarakpur and part of Lajpat Nagar	4·00
5.	Outfall sewer from Malvianagar	8·00
6.	Sewer along Mathura Road	5·00
7.	Sewers in Civil Lines area	2·00
8.	Duplication of rising main from Ring Road Pumping Station to high level gravity duct	10·00
9.	Replacement of the machinery of the Activated sludge plant at Okhla	15·00
10.	Gas Utilisation in the Industrial Estate in Okhla Works	10·00
11.	Secondary Treatment at Okhla	60·00
12.	Extension of Irrigation Channel	3·00
13.	Works for the elimination of some of the Pumping Stations	10·00
	TOTAL	164·00

STORM WATER DRAINAGE :

1.	Works for the separation of Sewage from S.W. drain	30·00
	TOTAL	194·00

III—WEST ZONE

1. *Topography of the land.*—This comprises of an area of 19,000 acres with a hilly land on the south sloping towards the Najafgarh Drain. The area on the other side of the drain steadily rises towards the East-West ridge line. A number of colonies have sprung up recently along the Najafgarh Road. A large number of industries with colonies for industrial workers have also recently been established. Rehabilitation Colonies have also been completed by the Ministry of Rehabilitation on very large scale. Refugee towns such as Patel Nagar (South, East and West), Tilak Nagar, Moti Nagar and many other private colonies such as Raja Park, Shivaji Park, Rajouri Garden have sprung up.

2. *Existing Sewerage system.*—Excepting the Cantonment area which also falls in this zone and which is situated on the plateau of the hill and Patel Nagars, none of the areas included in this Zone have any integrated sewerage system. Many of the colonies are served on dry latrines while colonies such as Rajouri Garden and Rehabilitation Colonies have to depend on the septic tanks for the disposal of the sewage. Patel Nagar—East, West and South, National Physical Laboratory, Pusa Institute, C.T.O. have internal sewerage systems, but they mostly have to depend on septic tanks, soakage pits and land irrigation. Sewage from Patel Nagar is intended to be treated in septic tanks but a large quantity has to be bypassed into the Najafgarh drain, as the capacity of the septic tanks has been found to be far too inadequate due to the increase in the population. Besides a number of new colonies are fast coming up. A milk dairy sponsored by the Union Government is also being established in this Zone. The need for the installation of a co-ordinated sewerage system on a regional basis and works for the disposal of the human and industrial wastes is therefore supreme and of immediate necessity.

3. *West side Purification Plant.*—Study of topography of this area reveals that it is possible to drain the whole area by gravity, that no subsidiary pumping stations are necessary and that only one plant for purifying the waste matter—both domestic and industrial is adequate for the whole area including Cantonment. The most suitable site for locating the plant was found to be near the Najafgarh drain behind the Tilak Nagar, where a large area of about 2000 acres of irrigable land is also available for cultivation.

After locating the site, steps were taken immediately towards the construction of the plant and a beginning was made early last year. The plant is designed to deal with 12 million gallons of sewage and industrial waste per day to a high degree of purity about 95 per cent and the effluent used mostly for irrigation. In case it is not used for irrigation, it will be discharged into the Najafgarh Drain after chlorination. Provision has also been made for the digestion of sludge and utilisation of sludge gas by converting the same into electricity by gas generator sets. The works have been completed.

4. *Main collecting sewers.*—There will be three main collecting sewers, one in the Najafgarh Road, the second along the Najafgarh drain and the third parallel to the Northern Railway Line. All these will discharge into the main pumping station of the West Side purification Plant. It will also be necessary to lay sewers in road No. 34 to catch the sewage from Patel Nagar and the dairy waste of the proposed milk colony. The sewage from the Cantonment can be connected to the sewer in Najafgarh Road near Tilak Nagar now under construction.

5. *Branch Sewer.*—Quite a few number of branch sewers will have to be constructed for serving the colonies already constructed and also those likely to be constructed in the near future. An extensive survey has been recently undertaken and detailed plans and estimates will be prepared.

6. *Cost of work in progress or completed.*—The cost of works either completed or under construction works out to Rs. 112 lakhs shown in Appendix 'A'.

7. *Works to be carried out in next four years.*—An extensive programme of laying sewers will have to be taken in hand and spread over a period of four to five years for placing this area on sound footing so far as sewerage is concerned.

		Cost Rs.	
SEWERAGE :			
1.	Laying collecting sewer along Najafgarh Drain	32·00	lakhs
2.	Laying collecting sewer along South of Najafgarh Road parallel to Rly. line	23·00	,,
3.	Sewer in Road No. 34	5·00	,,
4.	Branch Sewers	30·00	,,
5.	Irrigation Channels	3·00	,,
		93·00	,,
STORM WATER DRAINAGE :			
1.	Drains from Hari Nagar and Mehrauli	10·00	,,

IV—LOW LYING AREAS SUCH AS SHAHDARA, GITA COLONY, GANDHI NAGAR, KRISHNA NAGAR, ETC.

1. Part of Shahdara (South), Gandhi Nagar, Gita Colony and a dozen of other villages having a population of about a lakh of souls have become a matter of great concern during the last few years. The main difficulty in this area is the accumulation of rain water for which no exit has been provided.

2. *Topography.*—This area is about 3,000 acres sandwitched between the river Jamuna and the river Hindan. The Hindan Cut is on the south and a Northern Railway bund on the north side. A marginal bund constructed on the banks of the river Jamuna has effectively prevented the inrush of the river water when the river is in spate, but due to the non-provision of regulators at any point in the bund it is not possible to discharge into the river, the water accumulated on account of the rains from inside of the bund.

3. *Study of Hydrology of the river.*—On a detailed study of the hydrology of the river it is found that it will be possible to drain away the water inside the bund from the developed area by gravity into the river only for 31 days in a year—15 days in July and 16 days in September. Regulators if provided will therefore be useful for a short period only. For the rest of the period water will have either to be pumped out across the bund into the river or drained away by some other way.

Pumping out of water apart from the availability of pumps entails a considerable recurring expenditure and can only be considered if no other solution is possible. Besides pumps of high capacity are not available in this country.

4. *Possibility of storm water drainage by gravity.*—An alternative solution will be to exploit the advantages of the natural topography of the land, the major portion of which is favourable situated for drainage by gravity.

Examining the various contours it appears that 30 per cent of the area lies below RL 665 and 70 per cent at 665 and above. The developed areas are mostly situated on the high land except some parts like Gita Colony, part of Gandhi Nagar, Krishna Nagar, etc. A disused canal known as the diversion channel now completely silted, prevents the natural flow of water from the higher regions to the low lying area towards the south. It is proposed to make the fullest use of the diversion channel which was once constructed, for feeding the water from the Hindan River to the power house of the Delhi Electricity Undertaking for cooling purposes, by desilting it and using it as a main collecting channel to collect the storm water brought to it by the tributory channels to be constructed hereafter across the developed areas. From this diversion channel main outlet channels will be constructed upto the Hindan Cut. Outlets are already existing across the Hindan Cut, which is kept dry by provision of shutters on both sides near the Hindan river and Jamuna. At present during the rains the accumulated water upstream crosses the Hindan Cut through the openings provided for the purpose and flows downstream the Okhla weir, where the level of water is sufficiently low.

5. *Main reasons for flooding.*—The flooding in the Shahdara area—south is due to two causes :—

1. Rain water dropping in this area and
2. Surface water draining from the higher regions north of Northern Rly. line through some of the culverts under it.

The measures suggested above will deal with the rain water falling in the area, while the water draining to it from the Northern part (item 2) can be prevented by providing catch water drains along G.T. Road and draining it partly to the river on the west through the regulators provided in the Shahdara bund and to the East to the disused canal. The storm water from Dilshad Colony can also be connected to this drain. Negotiations with the Northern Railway for lowering the pipe culverts in front of Dilshad Colony are in progress.

Under this scheme no pumping of water will be necessary. Even under the worst flood conditions H. F. L. down stream Okhla Weir at no time exceeds R.L. 661·70. The past record shows that only in 1924 this level was exceeded.

6. *Low lying pockets.*—The low lying pockets in the developed areas which are not amenable to the gravity flow will have to be filled in due course or water from them pumped in into the tributory channels. Land may have to be acquired for constructing the channels.

7. *Cost.*—The cost of the scheme works out to be 10 lakhs. The main items of works will be :—

(*i*) Desilting the diversion channel.
(*ii*) Excavating the tributories and the main outlet channels.
(*iii*) Provision of brick pitching, concrete bedding for channels in (*ii*).
(*iv*) Cross drainage works wherever roads are crossed by channels.
(*v*) Acquisition of land and
(*vi*) Enlarging the outlets across the Hindan Cut.

8. *Sewerage.*—The whole of the area is served by dry latrine and the sullage flows through the open drain into the soakpits or lowlying pockets. It will be a long time before an underground sewerage system is constructed. During the course of next few years it is proposed to construct two night soil digestion tanks with accessories estimated to cost Rs. 7·60 lakhs. Their location and layouts will be so arranged that they will fit in with the future purification works and the underground sewerage system as and when they are constructed.

The works suggested will remove the nuisance now experienced due to the dumping of crude night soil in a most insanitary fashion.

COVERING OF OPEN STORM WATER DRAINS IN THE CITY

There are number of open drains in the City as listed below :.

1. Sunehrapul outfall drain starting from Lodi Road to Barapulla Nalla.
2. Drain No. 15, behind Sunder Nagar near the Zoo.
3. Drain along Mathura Road passing through the Exhibition ground.
4. Drain along Dr. Sen's Nursing Home from Mathura Road near Hardinge Bridge.
5. Drain passing at the back of C. B. R. Building.
6. Drain starting from P. K. Road Cremation Grounds upto Sunehrapul.
7. Drain from back of refugee market, Lodi Colony to its junction with Sunehrapul.
8. Karbea outfall drain near Safdarjang Tomb.
9. Kushak Nallah.
10. Barapula Nallah.
11. Drain from Lajpat Nagar to Jangpura.
12. Daryai Nalla.
13. City Ditch.
14. Najafgarh Drain.

Only three of these items are proposed to be covered under this plan.

1. Daryai Nallah—from Pusa Road upto Northern Railway near Rohtak Road.
2. Portion of Najafgarh Drain from Shakti Nagar to Mall Road.
3. Drain from Lajpat Nagar.

Cost of these works is estimated at Rs. 150 lakhs.

The total cost of all the works envisaged to be carried out in next four years is estimated at Rs. 555·60 lakhs as shown below zone wise:—

	Sewerage	S. W. Drainage	Total
	Lakhs	Lakhs	Lakhs
North Zone (p. 5)	81·00	10·00	91·00
South East Zone (p. 10)	164·00	30·00	194·00
West Zone (p. 12)	93·00	10·00	103·00
Shahdara (p. 15)	7·60	10·00	17·60
Covering of storm water drains in the city (p. 16)		150·00	150·00
TOTAL Rs. . .			555·60

SEWERAGE FACILITIES FOR THE OUTLYING COLONIES

South East Zone.—There are a number of outlying colonies in this zone. These are listed below :—

1. Kailash,
2. Greater Kailash.
3. Hauz Khas.
4. Green Park.
5. New Delhi South Extension.
6. Lajpat Nagar.
7. Malvia Nagar.
8. Kalkaji.
9. Friends Colony.

Internal sewers in some of these colonies are not yet laid. In the case of items Nos. 1 & 2 the internal sewers are laid and the outfall sewer is being laid upto Ring Road. It will be connected to the 30 in. dia. sewer to be laid by the Central P.W.D. and connected to one of the main sewers in this zone.

Re : Hauz Khas, Green Park and New Delhi South Extension (items Nos 3, 4 & 5)—the internal sewers are laid and outfall sewer is being laid. It will be connected to the existing sewer in Medical Enclave.

Re : Lajpat Nagar (item No. 6)—A portion of Lajpat Nagar is already sewered and a provision is made for providing sewerage facilities to the remaining area. This area will be drained into the existing main sewer to this zone.

Re : Malviya Nagar (item No. 7)—the internal sewers are being done by the Rehabilitation Ministry. A provision has been made for laying the outfall sewers.

Re : Kalkaji (item-No. 8)—the internal sewers are already laid. A provision has been made for providing an outfall sewer in the estimates.

Re : Friends Colony (item No. 9)—the internal sewers in the colony are not yet laid. There is a request from the colonisers to provide internal sewers at their cost. The work on the outfall sewer will be commenced shortly. This colony will be connected to the Ring Road Pumping Station.

West Zone.—There are a number of colonies abutting the Najafgarh Road such as Moti-Nagar, Kirti Nagar, Romesh Nagar, Tilak Nagar, Rajouri Garden. Most of these have their internal sewerage system. These colonies will be connected to the main sewer in Najafgarh Road now under construction.

Other colonies such as Shivaji Park, Raja Park, Shyama Pd. Mukherjee Park will be connected to the main sewer at the cost of the colonisers.

PHASE PROGRAMME OF WORK

All the works outlined in the above plan are important. It is not possible to find enough funds for all of them. The work will have to be phased and a programme will have to be made out for carrying out the most important works in the earlier stages, keeping back the less important works to be carried out in subsequent years. It is suggested that the whole programme should be completed within the next four years, *i.e.* from 1959 to 1963.

Phase programme of Works to be done during the next four years
In the year 1959-60

	(Rs in lakhs)
Branch Tributory Sewers draining into the Main Sewer (item 2 page 5)	17
Storm Water Pumps and Pump House (item 1 page 5)	6
Flood Gates (item 2 page 5)	3
Improvement of Storm Water Drains (item 3 page 5)	1
Sewer along Mathura Road (item 6 page 10)	5
Extension of irrigation Channels (item 2 page 10)	3
Replacement of the machinery of the activated sludge plant at Okhla (item 9 page 10)	15
Gas Utilisation in the Industrial Estate at Okhla (item 10 page 10) . .	10
Sewers in Kotla Mubarakpur and part of Lajpat Nagar (item 4 page 10) .	4
Cross Connections between Old and New Sewer (item 2 page 10) . .	9
Sewer in Road No. 34 (item 3 page 12)	5
Branch Sewers in West Delhi (item 4 page 12)	10
Drains from Harinagar, Mehrauli (item 6 page 12)	5
Storm Water Drain in Shahdara Zone (page 14)	10
Covering of Open Storm Water Drains	40
TOTAL	143

In the Year 1960-61

	(Rs. in lakhs)
Branch Sewers draining into Main Sewers (item 2 page 5)	18
Extension of sewer from Kalka Ambala Railway upto Old Rohtak Road (item 1 p. 5)	10
Extension of Trunk sewer from Delhi Gate to Red Fort	7
Cross Connections between Old and New Delhi Sewers Part (item 2 p. 10)	9
Works for the separation of Sewerage from Storm Water Drain (item 1 p. 10)	10
Branch Sewers in West Delhi (item 4 p. 12)	15
Irrigation Channels in West (item 5 p. 12)	3
Drain from Harinagar, Mehrauli etc. (item 6 p. 12)	5
Outfall sewer from Kalkaji (item 3 page 10)	5
Sewers in Civil Lines area (item 7 p. 10)	5
Gas Utilization Works (item 3 p. 5)	6
Covering of Open Storm Water Drains	40
TOTAL	130

In the year 1961-62

	(Rs. in lakhs)
Secondary Treatment, Okhla (item 11 p. 10)	30
Works for elimination of some pumping Stations in South E (item 13 p. 10)	5
Cross Connection between Old and New Sewer, Part (item 2 p. 10)	7
Works for the separation of sewage from S.W. (item 1 p. 18)	20
Laying collecting sewer along Najafgarh Drain (item 1 p. 12)	16
Laying collecting sewer along south of Najafgarh Road parallel to Rly. line (item 2 p. 12)	12
Branch Sewers in West Delhi (item 4 p. 12)	5
Outfall sewers from Malvianagar	8
Covering of open Storm Water Drains	40
TOTAL	143

In the year 1962-63

	(Rs. in lakhs)
Additional Units for Secondary Treatment of 10 M.G.D.	30
Secondary Treatment at Okhla (item 11 p. 10)	30
Works for the elimination of some pumping Stations (item 13 p. 10)	5
Duplication of Rising Main from Ring Road Pumping Station (item 8 p. 10)	10
Laying collecting sewer along Najafgarh Drain (item 1 p. 12)	16
Laying collecting sewer along South of Najafgarh Road parallel to Rly. Line (item 2 p. 12)	11
Night Soil Digestion Tanks (page 15)	7·6
Covering of open Storm Water Drains	30
TOTAL	139·6

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APPENDIX A

COST OF WORKS IN PROGRESS OR COMPLETED DURING THE LAST THREE YEARS

		(Rs. in lakhs)
North Zone		
1.	Pumping Station at Najafgarh Drain	65·00
2.	C. I. Rising main 2 miles long	
3.	Purification Plan—20 mgd. Primary Treatment	
4.	Secondary Treatment for 10 mgd.	26·00
5.	Main Sewer along Najafgarh Drain.	29·50
		120·50
West Zone		
1.	West Side Purification Plant complete treatment for 12 mgd.	78·00
2.	Sewer along Najafgarh Road	34·00
		112·00
South East Zone		
1.	Trunk Sewer from Delhi Gate to Ring Road	70·00
2.	Gravity duct from Kilokri to Okhla	35·00
3.	Ring Road Pumping Station	34·00
4.	Rising main from Ring Road Pumping Station to gravitation duct	11·00
5.	Sludge Digestion Plant IInd Stage at Okhla	28·56
6.	Okhla Sewage Treatment Plant Extension III	80·00
7.	Additional Pumps for Kilokri.	8·00
		266.56
	TOTAL	499·06

APPENDIX B

AREAS EARMARKED FOR DEVELOPMENT DURING NEXT FIVE YEARS

1. *North Zone—*

A. Area immediately last of village Dhaka upto Coronation Road and Military Parade Road towards North (80 acres).

B. Area bounded by Grand Trunk Road, Pambari Road, Polo Road and Rajpur Village (40 acres).

C. Area bounded by Kingsway, Southern boundary of All India Radio Transmission Station, Princess Road and Infectious Disease Hospital (60 acres).

D. Shakurpur—(90 acres).

E. Wazirpur—(80 acres).

2. *South East Zone—*

A. Kilokri, bounded as under: North Boundary of Kilokri Sewage Pumping Station.
East—Boundary of Village Kilokri.
South—Ring Road.
West—Sewage Gravity Duct (70 acres).

B. Arakpur Bagh Mochi bounded as under :
North-West — Kitchner Road.
South-West — Ring Road.
North-East — Railway Colony.
South-East — Moti Bagh Colony (250 acres).

C. Areas South of Okhla Sewage Plant near village Madanpur, immediately South of the approach road leading to Madanpur village (13 acres).

D. Area bounded as under :
North—Boundary of Government Land.
East—Mehrauli Road.
West—Abadi Known as Krishna Nagar.
South—Colony of Green Park as approved by the Delhi Development provisional Authority (60 acres).

3. *West Zone—*

A. Area bounded by Patel Road, the boundary of Pusa Institute and Metre Gauge Railway Line to Palam extending to a distance of 2700 ft. from the junction of Patel Road and Railway Line, excluding Shadipur and Khampur village and Ranjit Nagar area (230 acres).

B. Area popularly known as Motinagar and bounded by Pusa Road, boundary of Western Extension Area, boundary of East Patel Nagar and defence land and extension of Arya Samaj Road (70 acres).

C. Tehar Village—(62 acres).

D. Area bounded by Railway line Pusa Institute. Area bounded by Railway line Pusa Institute Boundary Nariana Village and Road No. 34 extension of Patel Road (500 acres).

4. *Colonies East of River Jamuna—*

A. Area bounded as under :
East—Eastern Jamuna Canal.
South—Grand Trunk Road to Meerut.
North—Gokalpur escape from the eastern Jamuna Canal.
West—Gokalpur escape (100 acres).

B. Jhilmila Tahirpur bounded as under :
North—Grand Trunk Road.
East—Boundary of the Union Territory of Delhi.
South—Northern Boundary of village Kartar Duma.
West—Boundary line between the revenue estate of Jhilmila Tahirpur and Shahdara from Schadda to the Railway Line, thence towards East along the Railway line upto a distance of 1980 ft. thence north along an imaginary line joining the Grand trunk Road (600 acres).

APPENDIX VI

LIST OF VILLAGES IN THE NAJAFGARH CATCHMENT WHERE THERE IS COMPLAINT OF WATER LOGGING

1. Puth Kalan
2. Begampur
3. Kanjhawla
4. Ladpur
5. Kotoora
6. Shakur Basti
7. Shakarpur
8. Shikarpur
9. Jhatikra
10. Ghuman Hora
11. Raota
12. Rithela
13. Baproal
14. Gowla Khurd
15. Pochanpur
16. Kakraula
17. Dichacon Kalan
18. Mitraoon
19. Nawada
20. Ambar Hai
21. Khora
22. Rinaula
23. Nangal Thakran
24. Palla
25. Nilokhari
26. Sarai Kale Khan
27. Nali Rizapur
28. Ghonda
29. Madhpur Ramsanpur
30. Mukand Pur
31. Bhalswa J. Pur
32. Dhulsaras
33. Nangli Sakrawat
34. Hastsal
35. Talangpur Kotla
36. Budhola
37. Nilothi
38. Nankheri
39. Kangan Hari
40. Badhsra
41. Naya Bans
42. Between Hulambi and Khera Khurd
43. Chillae
44. Goora
45. Saoda
46. Chandpur
47. Majra Dabas, Budanpur and Salchpur
48. Badli
49. Khizrabad
50. Shahibabad Daulatpur
51. Nilwal
52. Hiran Kudana

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APPENDIX VII

PHASED PROGRAMME OF COSTS—STORM WATER DRAINAGE

(Figures in Lakhs)

Serial No.	Description	Estimate Cost	Delhi Corporation			New Delhi Municipal Committee			Central Government		
			I	II	III	I	II	III	I	II	III
1	2	3	4	5	6	7	8	9	10	11	12
	A. BLOCK I										
1	Desilting and sectioning of Nallahs	5·39	3·89	..	..	1·50	..	..	..	..	..
2	Relief Drain behind Fire Brigade Lane	0·67	..	..	..	0·67	..	..	..	..	..
3	Remodelling of Karbala Drain	1·56	..	..	..	1·56	..	..	..	..	..
4	Independent out fall for Golf Link Colony	0·20	..	..	..	0·20	..	..	..		..
5	Improvement in Market Road area	0·19	..	..	..	0·19	..	..	..	..	..
6	Improvement in Minto Road area	0·20	0·20	..	..	..	..	..	..	..	..
7	Regarding of Kushak'Nalla	1·86	..	..	..	1·86	..	..	..	..	..
8	Provision of Pumps at Minto Road Bridge	0·50	0·50	..	..	..	..	..	..	..	..
9	Remodelling of Sonehripul Nalla	0·78	..	..	..	0·78	..	..	..	..	..
10	Improvement of interception in pre 1939 New Delhi	20·06	..	..	..	..	20·06	..	..	..	..
11	Augmentation of out fall channel No. 3	27·09	..	..	..	..	27·09	..	..	..	..

[Figures in Lakhs)

Serial No.	Description	Estimate Cost	Delhi Corporation			New Delhi Municipal Committee			Central Government		
			I	II	III	I	II	III	I	II	III
1	2	3	4	5	6	7	8	9	10	11	12
	A. BLOCK I—*contd.*										
12	Augmentation of Main drains in pre 1939 New Delhi	138·18	..	..	..	..	..	138·18	..	..	..
13	Remodelling Mathura Road Bridge and Barapulla Bridge	12·00	..	12·00	..	..	..	..	..	..	..
14	Remodelling of Lajpat Nagar Nalla	1·65	..	1·65	..	..	..	..	..	..	..
15	Remodelling of Friends' Colony Nalla . .	1·50	..	1·50	..	..	..	..	..	..	..
16	Providing pumping station for Nizamuddin .	7·20	..	..	7·20	..	..	..	..		
17	Providing bunds for Barapulla Nalla . . .	1·50	..	..	1·50	..					
18	Providing syphon under Railway Bridge over Barapulla Nalla	6·00	..	..	6·00						
19	Providing pumps under Hardinge Bridge . .	·50	..	..	·50	..	..	..			
20	Remodelling of Road bridges where necessary .	10·00	..	8·00	..	..	2·00	..	..	..	..
	TOTAL . .	237·03	4·59	23·15	15·20	6·76	49·15	138·18	..	..	..

B. BLOCK II										
1 Removal of humps and regrading the bed of Najafgarh Drain in a reach of 10 miles and de-silting of Mangespur and Nangloi Drains	150	..	..	..	..	..	..	2·7	..	..
2 Resectioning of Najafgarh Drain from RD 65,000 to RD 1,38,000 including remodelling of bridges		..	..	..	..	..	..	..	25·9	..
3 Long term plan for complete relief	..	..	..	..	..	..	..	..	..	121·4
4 Stormwater pumps and pump house near Shah Alam Bridge	6	..	6	..	..	..	..	..	..	..
5 Provision of flood gates in the bund	3	..	3	..	..	..	..	..	..	..
6 Improvement of stormwater drains	1	..	1	..	..	..	..	..	..	..
7 Stormwater drains from Hari Nagar and Mehrauli	10	..	5	5	..	..	..	..	..	..
TOTAL	170	..	15	5	..	..	..	2·7	25·9	121·4
C. BLOCK III										
1 Separation of sewerage and stormwater in Old Delhi City	30·00	..	..	30·00	..	..	..	..	..	..
D. BLOCK IV										
1 Improvements to drainage	42·00	5·00	..	37·00	..	..	..	..	..	..
GRAND TOTAL of A, B, C & D	479·03	9·59	38·15	87·20	6·76	49·15	138·18	2·7	25·9	121·4

APPENDIX VIII

PHASED PROGRAMME OF COST FOR SEWERAGE

(FIGURES IN LAKHS)

Serial No.	Description	Total Cost	Corporation Phase I	Corporation Phase II	Corporation Phase III	N.D.M.C. Phase I	N.D.M.C. Phase II	N.D.M.C. Phase III
	A. *South East Zone*							
1.	Laying of relief sewers in New Delhi area	7	..	..	..	7	..	..
2.	Extension of new trunk sewer from Delhi Gate to Red Fort	7	..	..	7	..	..	..
3.	Duplicate rising main from Ring Road pumping station to high level gravity duct.	10	..	..	10	..	..	..
4.	Cross connection between old and new sewers	25	..	9	16	..	..	..
5.	Outfall sewer for Malvianagar	8	..	..	8	..	..	..
6.	Outfall sewer for Friends Colony	5	..	5	..	..	..	..
7.	Internal Sewers in part Lajpat Nagar and Kotla Mubarakpur	4	..	4	..	..	..	..
8.	Internal sewers in Civil Lines area	2	..	..	2	..	..	..
9.	Additional secondary treatment plant at Okhla for 30 M.C.D.	60	..	..	60	..	..	..
10.	Extension of irrigation channels at Okhla	3	..	3	..	..	..	..
11.	Renewal of machinery of the activated sludge plant at Okhla	15	..	15	..	..	..	..
12.	Gas utilisation at Okhla	10	..	10	..	..	..	..
13.	Cross connections with the new sewers to eliminate some of the subsidiary pumping stations	10	..	..	10	..	..	..
	TOTAL	166	..	46	113	7	..	..

B. *North Zone*							
1. Gas utilisation works at North plant	6	..	..	6	..	..	..
2. Additional treatment units of 10 M.C.D. at North site plant	30	..	..	30	..	..	..
3. Extension of trunk sewer from Delhi-Ambala Railway line up to old Rohtak Road	10	..	..	10	..	..	..
4. Branch sewers in North Zone	35	..	17	18	..	..	..
TOTAL	81	..	17	64	..	..	..
C. *West Zone*							
1. Irrigation Channels at Tilak Nagar plant	3	..	..	3	..	..	..
2. Trunk sewer along Najafgarh drain	32	..	..	32	..	..	..
3. Trunk sewer south of Najafgarh Road parallel to Railway line	23	..	..	23	..	..	..
4. Branch Sewers in West Zone	30	..	..	30	..	..	..
TOTAL	88	..	..	88	..	..	..
D. *Shahdara Area*							
1. Installation of two night soil digestion tanks	7·6	7·6	..	..	..	..	..
2. Providing permanent sewerage arrangements for Shahdara area complete with purification plant	139·0	..	..	139	..	..	..
TOTAL	146·6	7·6	..	139	..	..	..
GRAND TOTAL	481·6	7·6	63	404	7	..	..

APPENDIX IX

GRAND SUMMARY OF COSTS AND PHASING

(FIGURES IN LAKHS)

Serial No.	Description	Corporation				N.D.M.C.				Delhi Admn.				Ministry of W.H. & S.			
		Phase I	Phase II	Phase III	Total	Phase I	Phase II	Phase III	Total	Phase I	Phase II	Phase III	Total	Phase I	Phase II	Phase III	Total
1.	Improvement to storm water drainage	9·59	38·15	87·20	134·94	6·76	64·83	122·50	194·09	2·7	25·9	121·4	150·00	..	..	..	..
2.	Improvement to sewerage	7·6	63	404	474·6	7	..	..	7	..	..	..	..	..	..	..	..
3.	Lowering the sub-soil water table and stabilising it	..	..	..	..	..	..	..	..	..	..	..	..	30	..	..	30
4.	Flood protection works	..	..	..	..	..	..	..	..	4·0	..	..	4·0	..	..	..	..
5.	Equipment	4	..	..	4	·8	..	..	0·8	..	..	..	..	5	..	..	5
		..	..	..	613.54	..	..	..	201·89	..	..	..	154	..	..	..	35

GMGIPND—M—154 WHS—13-3-59—1,200.

PLANS REFERRED TO IN THE REPORT

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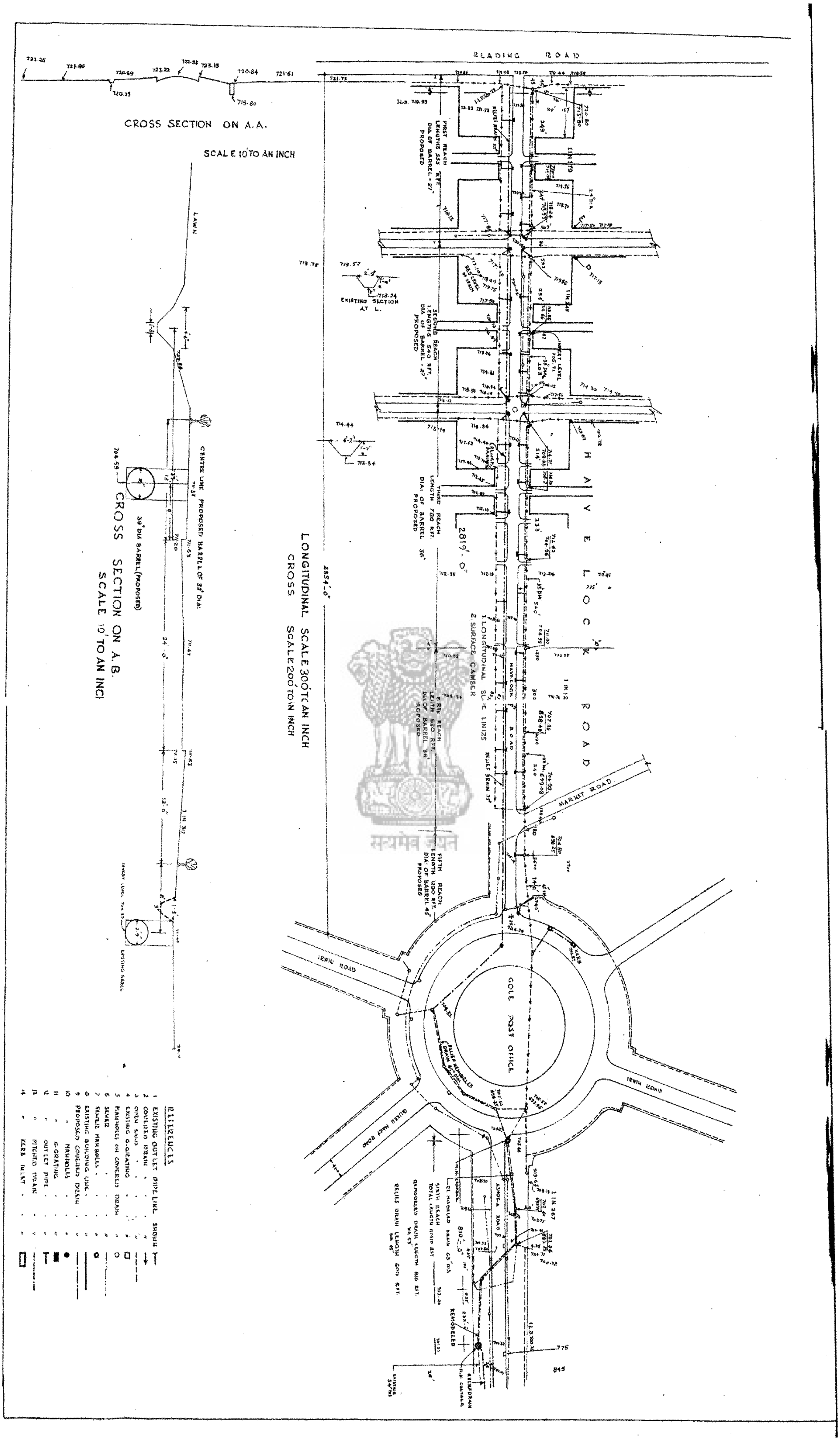
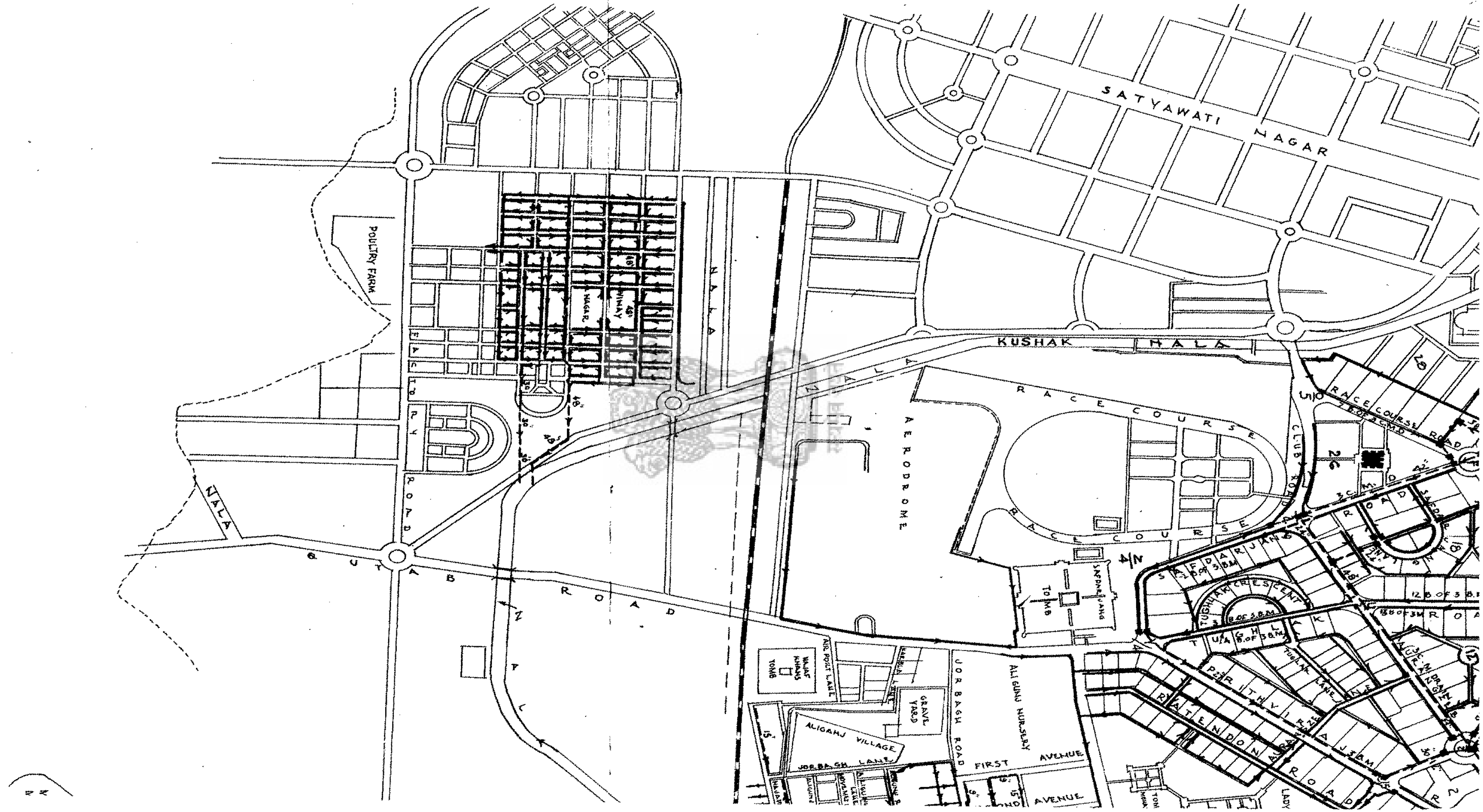
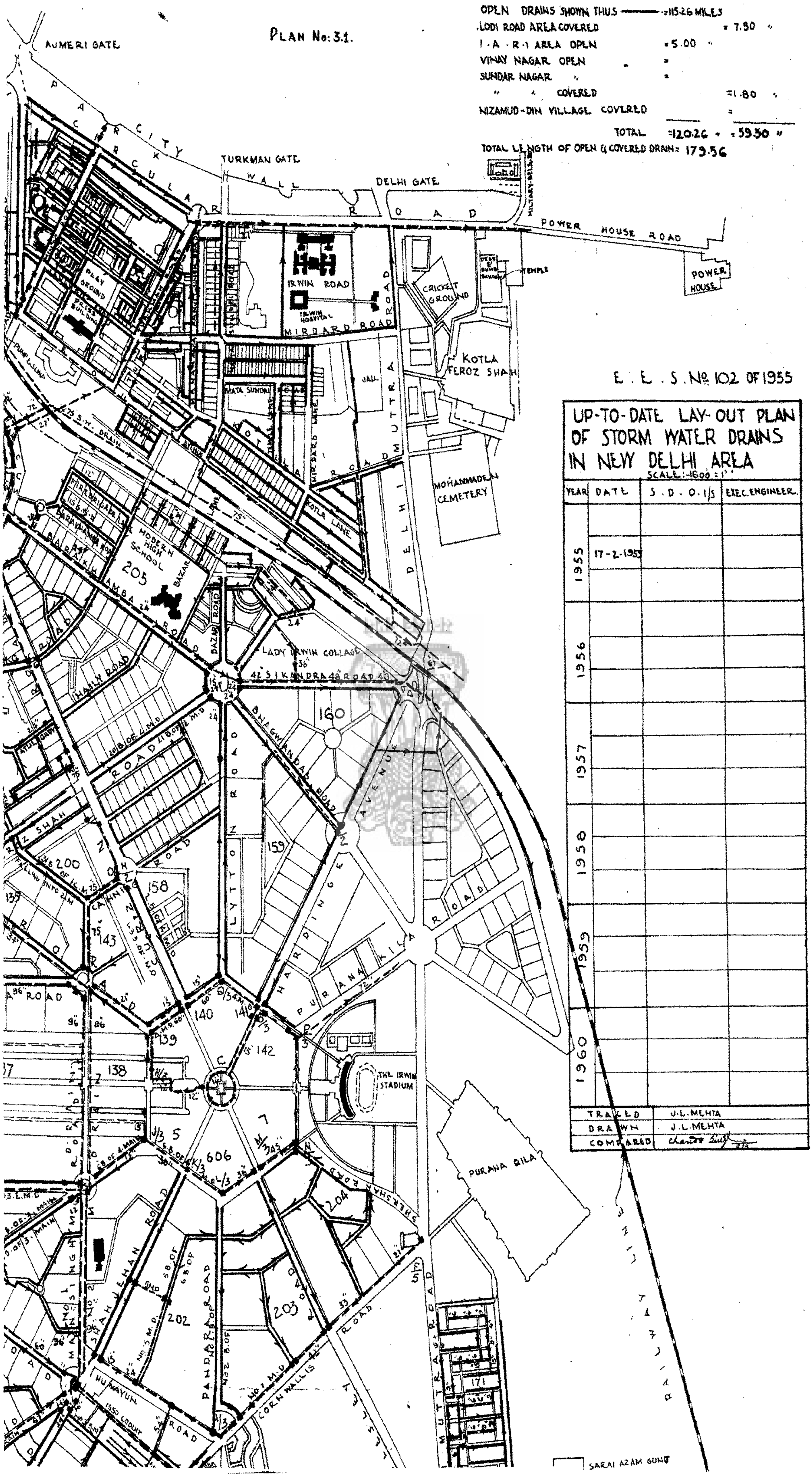

READING ROAD
CROSS SECTION ON A.A.
SCALE 10' TO AN INCH
LAWN
CENTRE LINE PROPOSED BARREL OF 39" DIA.
39" DIA BARREL (PROPOSED)
CROSS SECTION ON A.B.
SCALE 10' TO AN INCH
EXISTING BARREL
LONGITUDINAL SCALE 300' TO AN INCH
CROSS SCALE 200' TO AN INCH
FIRST REACH LENGTH 585 RFT. DIA OF BARREL 27" PROPOSED
SECOND REACH LENGTH 540 RFT. DIA OF BARREL 27" PROPOSED
THIRD REACH LENGTH 780 RFT. DIA OF BARREL 36" PROPOSED
FIFTH REACH LENGTH 1290 RFT. DIA OF BARREL 45" PROPOSED
EXISTING SECTION AT L.
2819'-0"
2854'-0"
1. LONGITUDINAL SLOPE 1 IN 125
2. SURFACE CAMBER
HAVELOCK ROAD
RELIEF DRAIN
INVERT LEVEL
1 IN 179
1 IN 245
1 IN 12
1 IN 30
1 IN 267
MARKET ROAD
IRWIN ROAD
QUEEN MARY ROAD
GOLE POST OFFICE
KERB INLET
ASHOKA ROAD
SIXTH REACH TOTAL LENGTH
REMODELLED DRAIN 63" DIA
REMODELLED DRAIN LENGTH 810 RFT. DIA 63"
RELIEF DRAIN LENGTH 600 RFT. DIA 45"
810'-0"
REMODELLED
RELIEF DRAIN
M.H. CHAMBER
EXISTING 54" DIA
775
845
REFERENCES
1 EXISTING OUT LET PIPE LINE SHOWN
2 COVERED DRAIN
3 OPEN SIDE
4 EXISTING G-GRATING
5 MANHOLES ON COVERED DRAIN
6 SEWER
7 SEWER MANHOLES
8 EXISTING BUILDING LINE
9 PROPOSED COVERED DRAIN
10 MANHOLES
11 G-GRATING
12 OUT LET PIPE
13 PITCHED DRAIN
14 KERB INLET


SATYAWATI NAGAR
POULTRY FARM
VINAY NAGAR
48"
NALA
KUSHAK NALA
FACTORY ROAD
RACE COURSE
AERODROME
QUTAB ROAD
NALA
SAFDARJANG TOMB
NAJAF KHAN'S TOMB
AIR PORT LANE
GRAVE YARD
ALIGANJ VILLAGE
ALIGANJ NURSERY
JOR BAGH ROAD
JOR BAGH LANE
FIRST AVENUE
AVENUE
CLUB ROAD
RACE COURSE ROAD
SAFDARJANG ROAD
TUGHLAK CRESCENT
TUGHLAK ROAD
TUGHLAK LANE
PRITHVIRAJ ROAD
RATENDON ROAD
AURANGZEB ROAD
LADY
N

PLAN No: 3.1.

OPEN DRAINS SHOWN THUS ——— =115.26 MILES
LODI ROAD AREA COVERED = 7.30 "
I.A.R.I AREA OPEN =5.00 "
VINAY NAGAR OPEN =
SUNDAR NAGAR " =
" " COVERED =1.80 "
NIZAMUD-DIN VILLAGE COVERED =
TOTAL =120.26 " =59.30 "
TOTAL LENGTH OF OPEN & COVERED DRAIN= 179.56

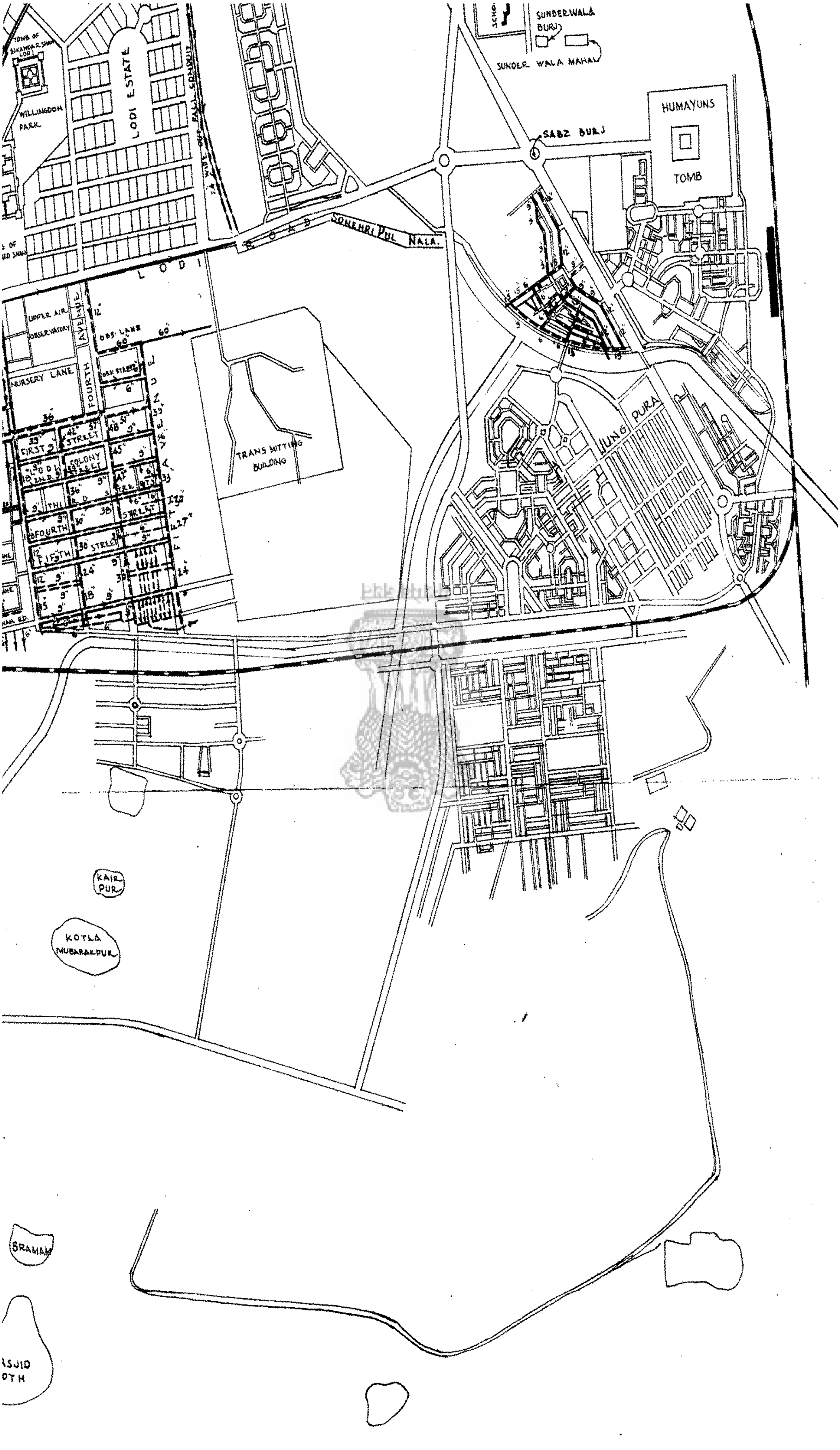


E . E . S . No. 102 OF 1955

UP-TO-DATE LAY-OUT PLAN
OF STORM WATER DRAINS
IN NEW DELHI AREA
SCALE:-1600 = 1"

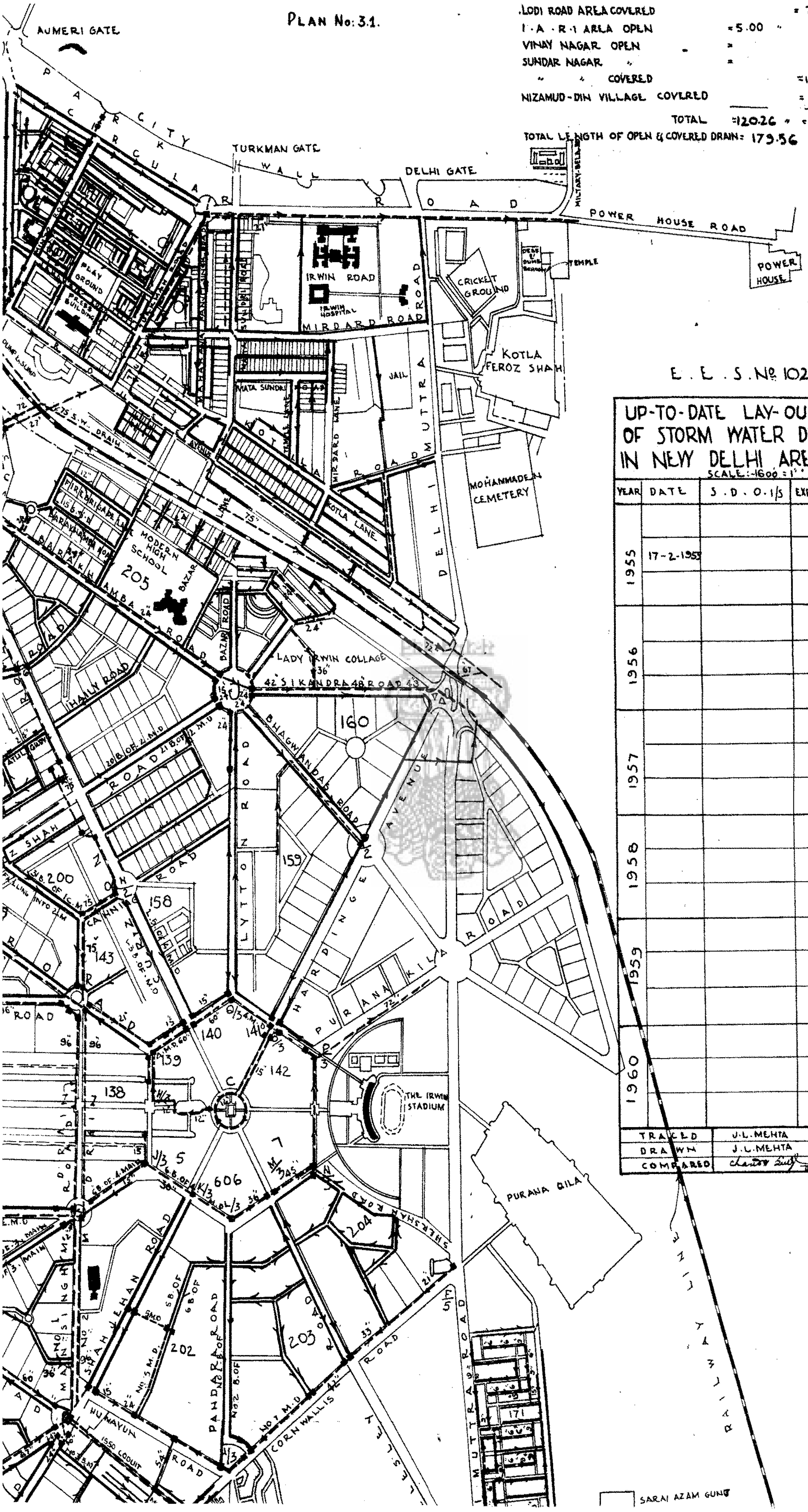
YEAR	DATE	S.D.O.I/S	EXEC. ENGINEER.
1955			
	17-2-1955		
1956			
1957			
1958			
1959			
1960			

TRACED	J.L.MEHTA
DRAWN	J.L.MEHTA
COMPARED	Chandra


TOMB OF SIKANDAR SHAH LODI
WILLINGDON PARK
LODI ESTATE
7.4 WIDE OUT FALL CONDUIT
SUNDERWALA BURJ
SUNDER WALA MAHAL
HUMAYUNS TOMB
SABZ BURJ
SONEHRI PUL NALA.
LODI ROAD
UPPER AIR OBSERVATORY
FOURTH AVENUE
OBS: LANE
OBY. STREET
NURSERY LANE
FIRST STREET
COLONY STREET
LODI
2ND ROAD
THIRD STREET
FOURTH
FIFTH
30 STREET
FIFTH AVENUE
TRANS MITTING BUILDING
JUNG PURA
KAIR PUR
KOTLA MUBARAKPUR
BRAMAM
ASJID OTH
60"
36"
33"
42"
57"
48
51"
45"
9"
6"
12"
24"
30"
38"
18"
15
39"
27"

PLAN No: 3.1.

.LODI ROAD AREA COVERED = 7.50 "
I·A·R·I AREA OPEN = 5.00 "
VINAY NAGAR OPEN =
SUNDAR NAGAR " =
" " COVERED = 1.80 "
NIZAMUD-DIN VILLAGE COVERED =
TOTAL = 120.26 " = 59.30 "
TOTAL LENGTH OF OPEN & COVERED DRAIN: 179.56



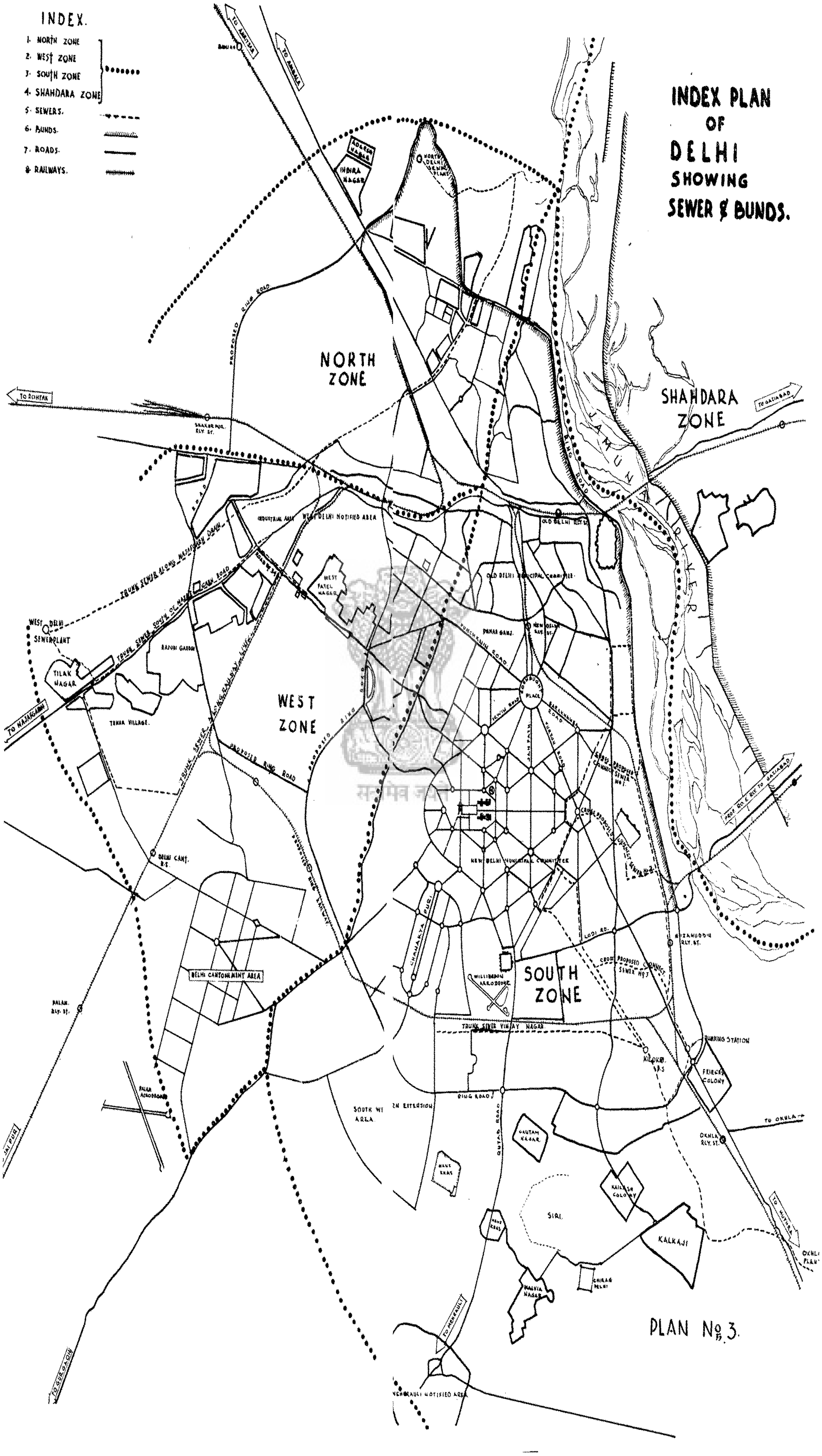
E . E . S . No 102 OF 1955

UP-TO-DATE LAY-OUT PLAN OF STORM WATER DRAINS IN NEW DELHI AREA

SCALE:-1600 = 1"

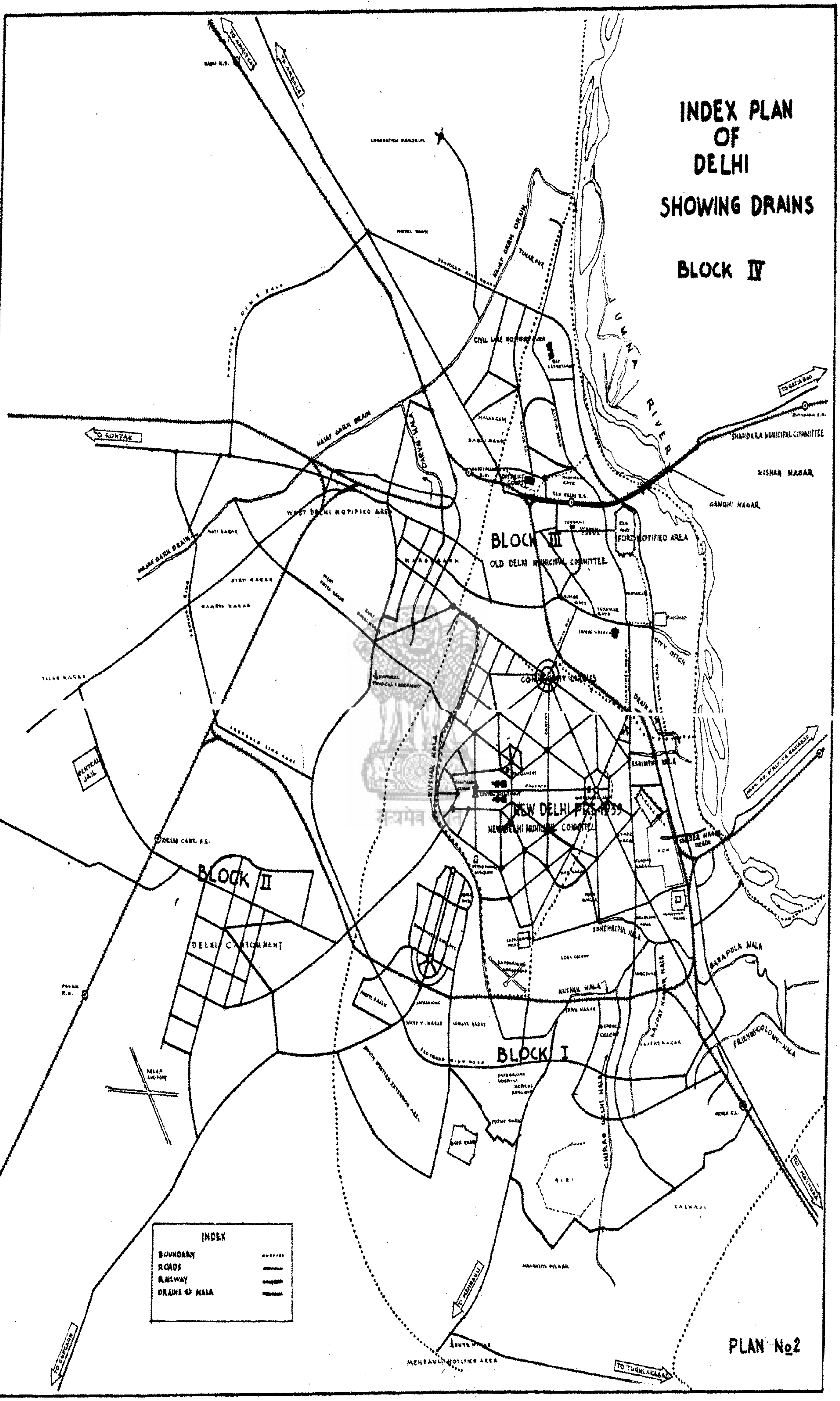
YEAR	DATE	S.D.O.I/S	EXEC. ENGINEER.
1955			
	17-2-1955		
1956			
1957			
1958			
1959			
1960			

TRACED	J.L. MEHTA
DRAWN	J.L. MEHTA
COMPARED	Chander Bux



INDEX PLAN OF DELHI SHOWING SEWER & BUNDS.

PLAN No. 3.



INDEX PLAN OF DELHI SHOWING DRAINS

BLOCK IV

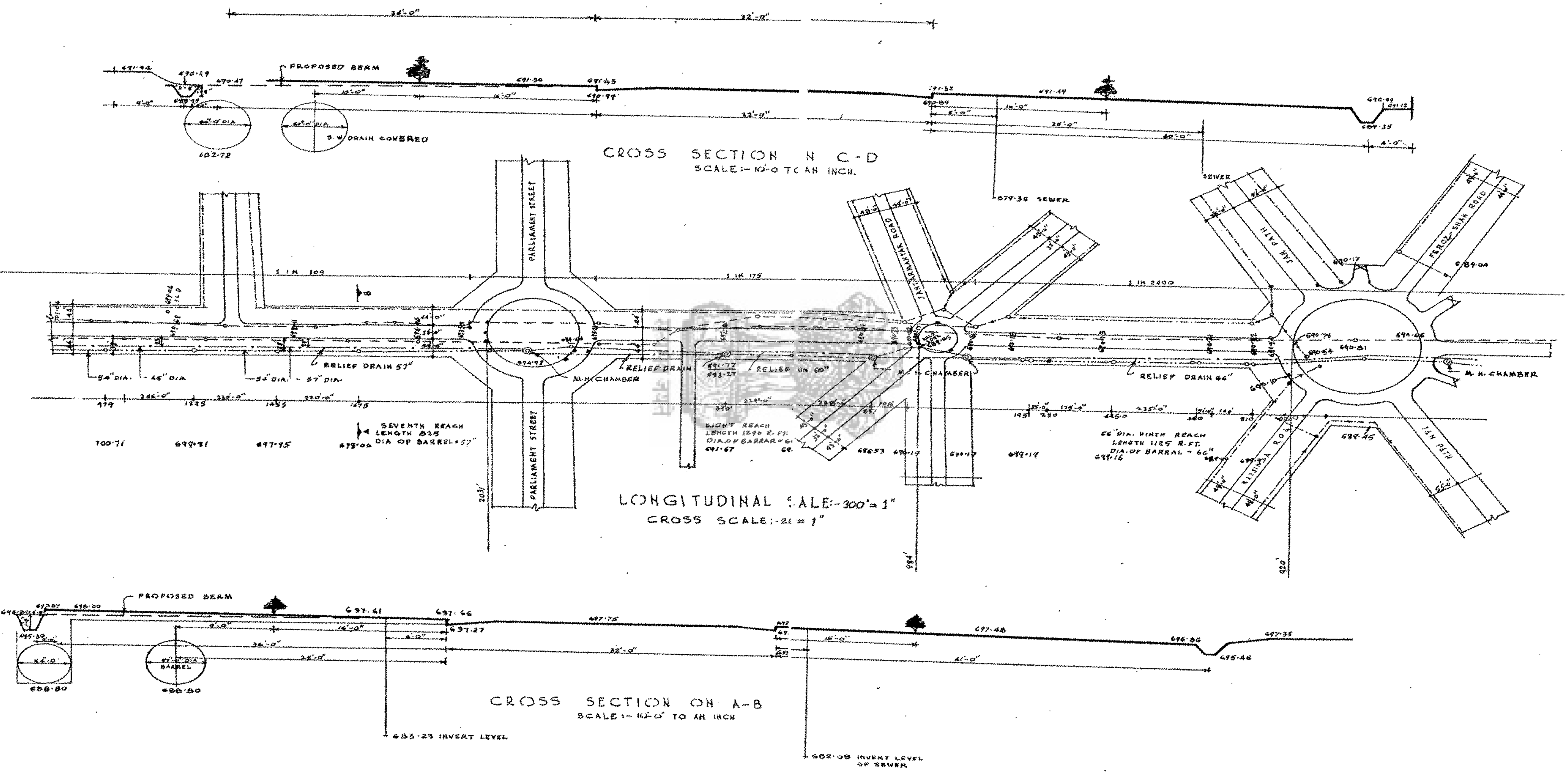
PLAN No2

PLANS REFERRED TO IN APPENDIX III

सत्यमेव जयते

DRAIN No 1 C. FROM G. P. O TO JANPATH

PLAN No 5.3.
SHEET NO 1

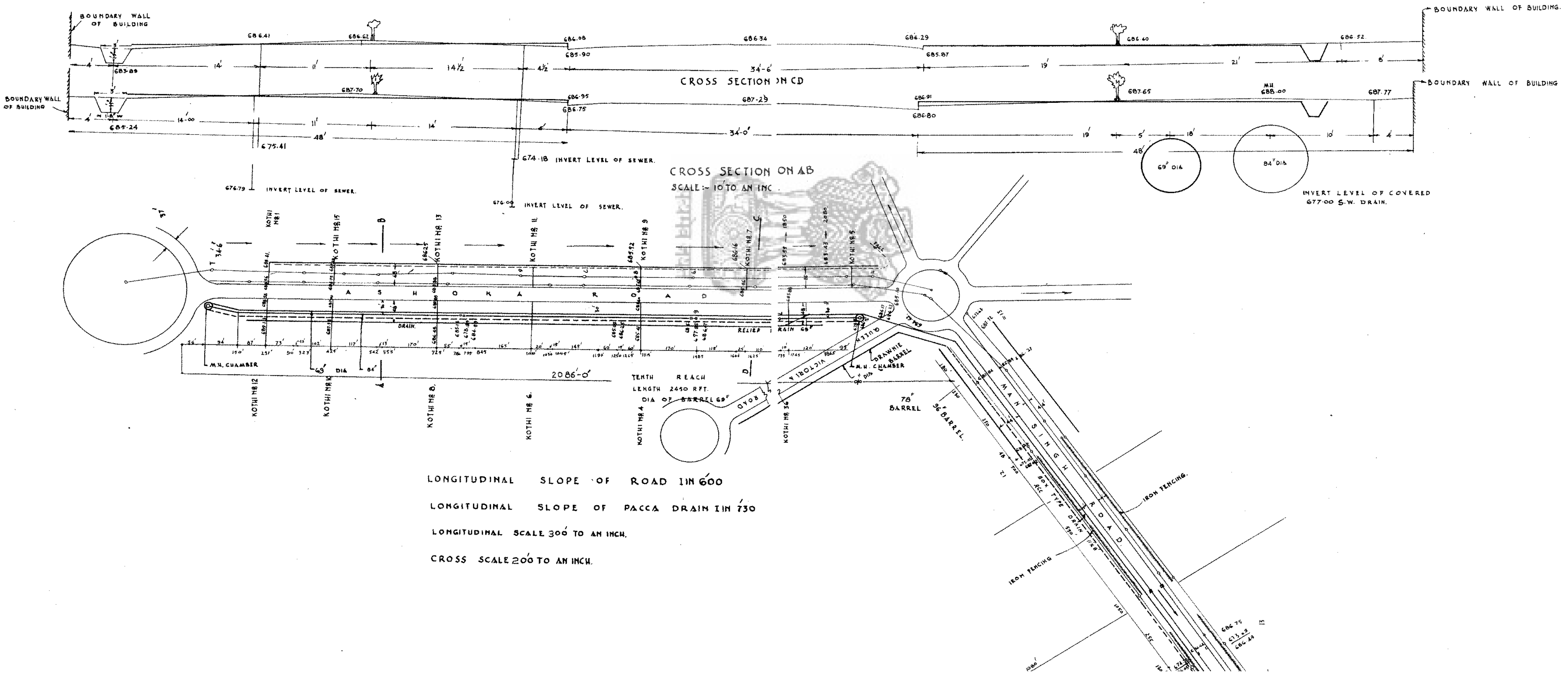


DRAIN NC1C

FROM

ASHOKA ROAD TO MAN SINGH ROAD

PLAN NO. 5.4.
SHEET NO 1

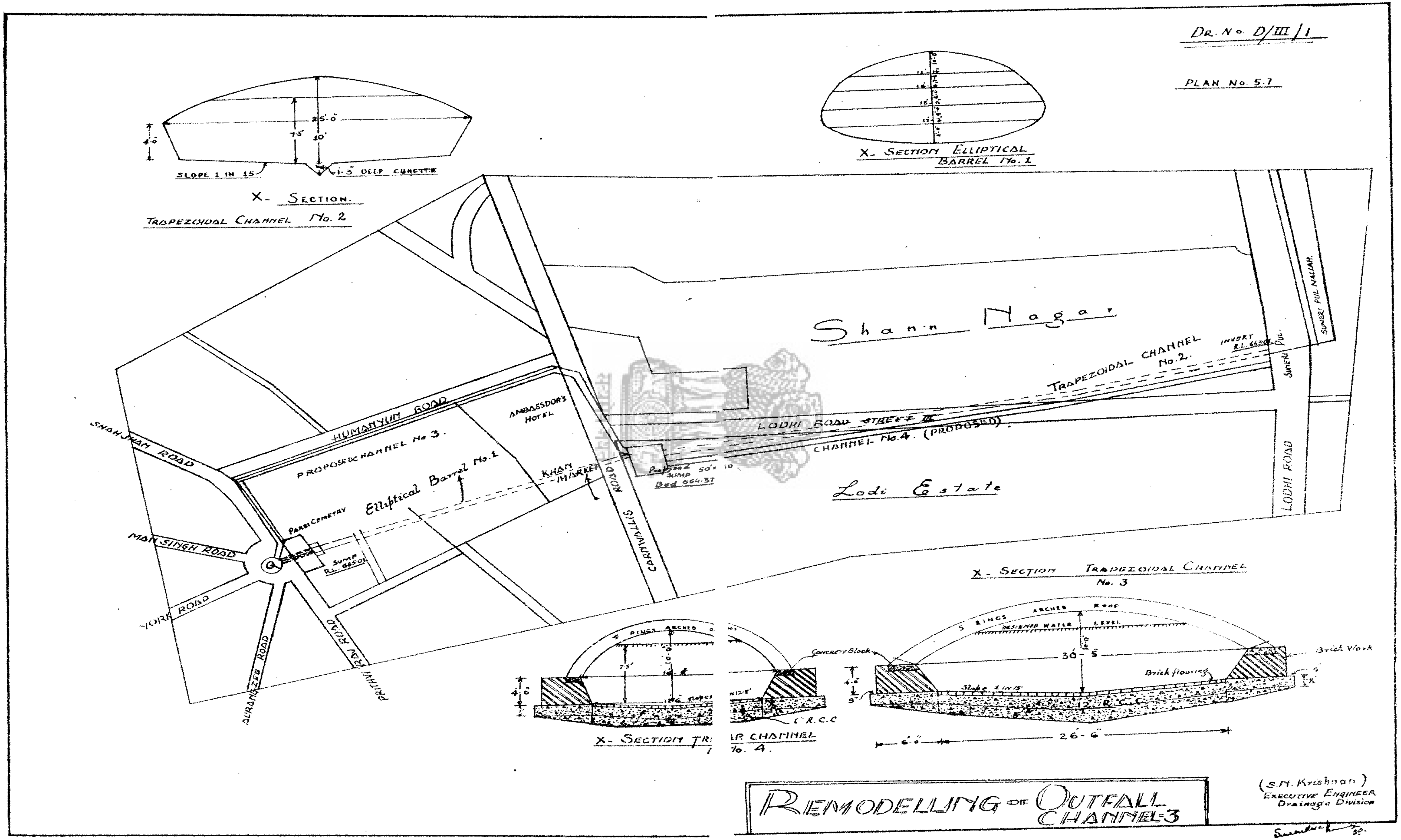


LONGITUDINAL SLOPE OF ROAD 1 IN 600

LONGITUDINAL SLOPE OF PACCA DRAIN 1 IN 730

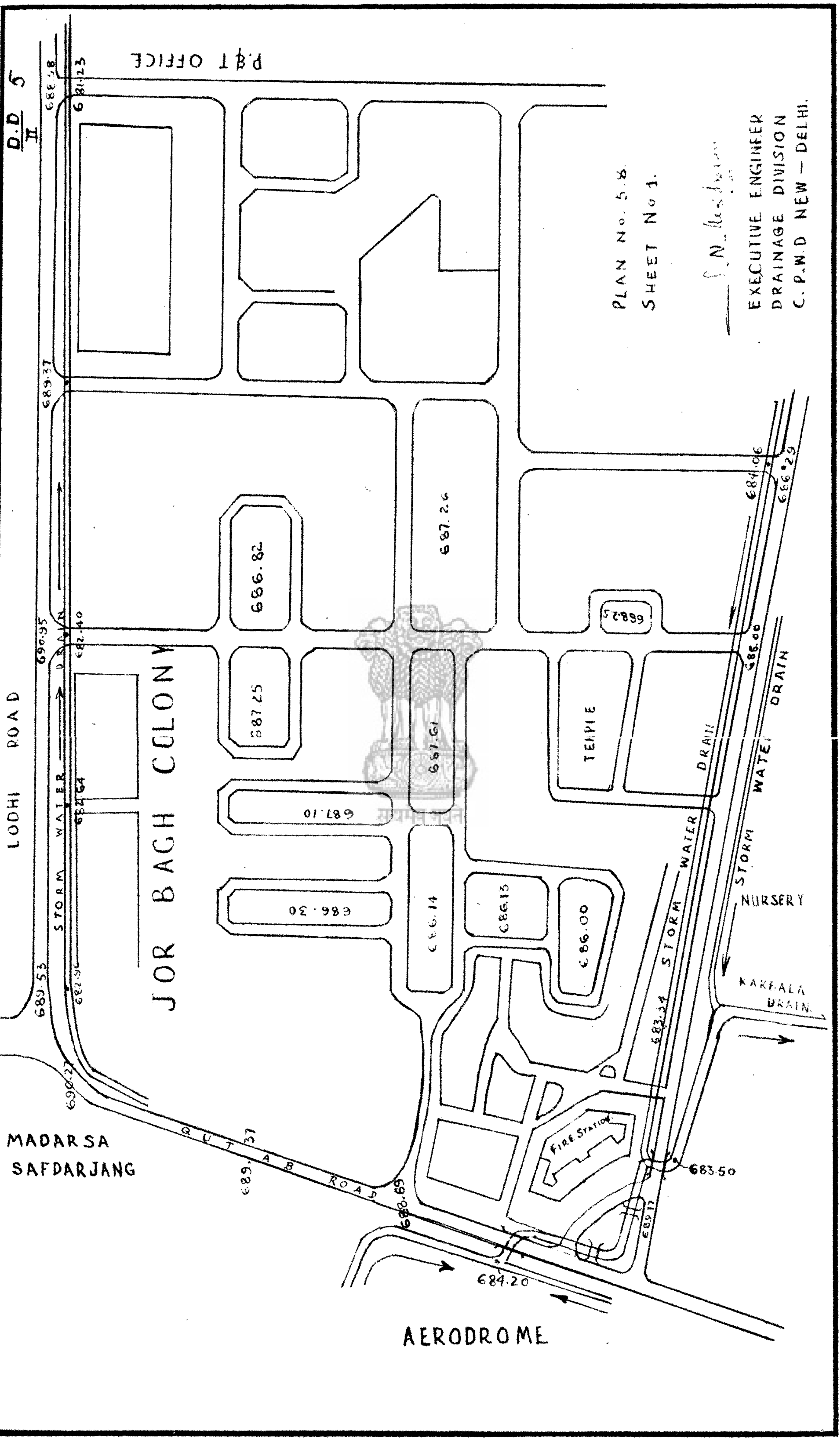
LONGITUDINAL SCALE 300' TO AN INCH.

CROSS SCALE 200' TO AN INCH.



Dr. No. D/III/1
PLAN No. 5.7
X- Section Elliptical Barrel No. 1
X- Section. Trapezoidal Channel No. 2
25'-0"
7'5"
10'
4'-0"
Slope 1 in 15
1'-3" deep cunette
Shan'n Nagar
Lodi Estate
Trapezoidal Channel No. 2.
Invert R.L. 663.…
Suneri Pul.
Suneri Pul Nallah.
Lodhi Road
Lodhi Road Street III
Channel No. 4. (Proposed).
Proposed 50'x10' Sump Bed 664.37
Carnwallis Road
Khan Market
Ambassdor's Hotel
Humanyun Road
Proposed Channel No. 3.
Elliptical Barrel No. 1
Parsi Cemetry
Sump R.L. 665.01
Shahjhan Road
Mansingh Road
York Road
Aurangzeb Road
Prithvi Raj Road
X- Section Trapezoidal Channel No. 3
5 Rings Arched Roof
Designed Water Level
30'-5"
10'-0"
4'-0"
9"
Concrete Block
Brick Work
Brick flooring
Slope 1 in 15
12" R.C.C.
6'-0"
26'-6"
X- Section Trap Channel No. 4.
4 Rings Arched
7'5"
4'-0"
C.R.C.C
Remodelling of Outfall Channel-3
(S.N. Krishnan)
Executive Engineer
Drainage Division

D.D/II 5



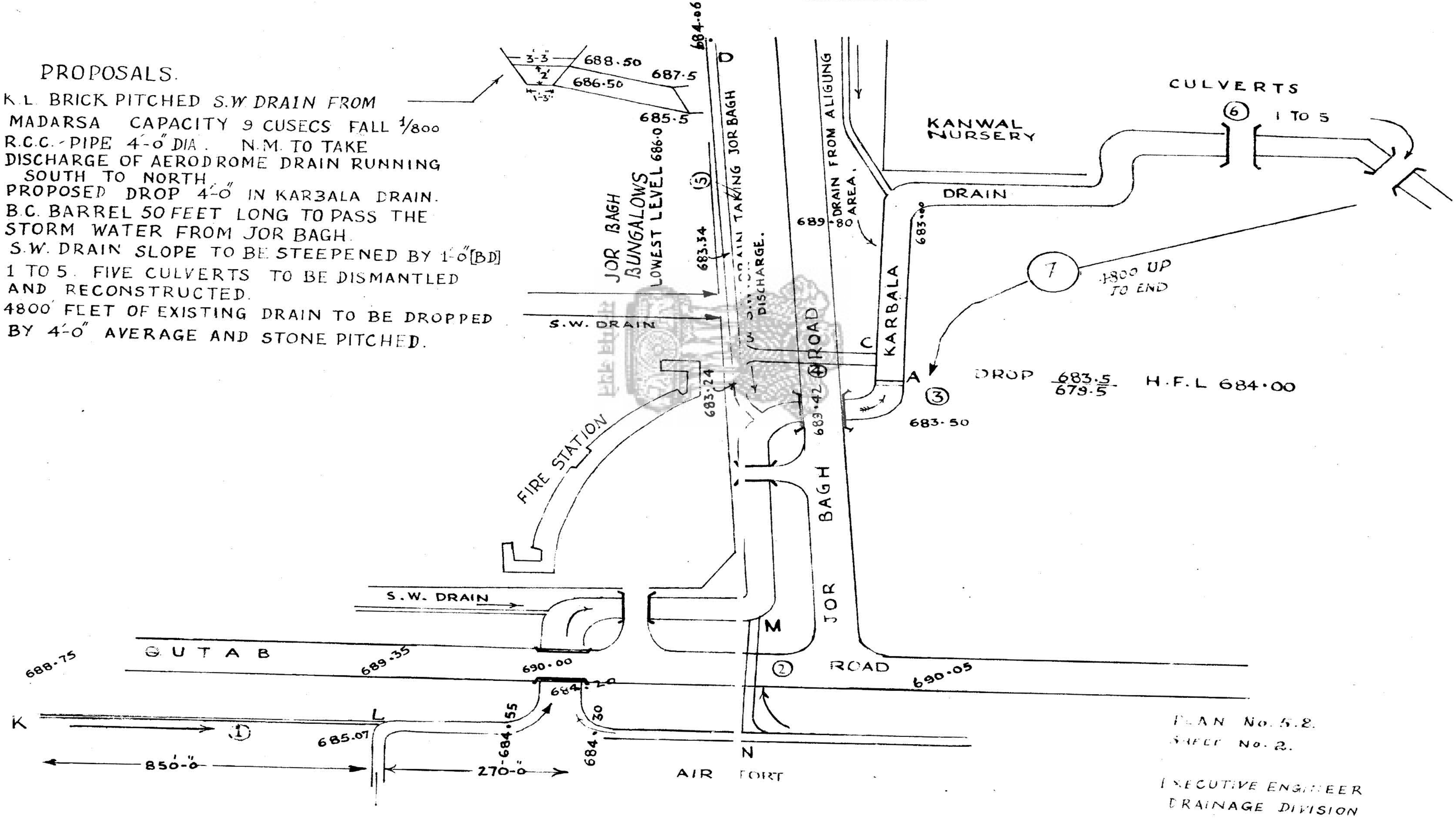
PLAN No. 5.8.
SHEET No 1.

S. N. [illegible]
EXECUTIVE ENGINEER
DRAINAGE DIVISION
C.P.W.D NEW-DELHI.

DETAILS SHOWING PROPOSALS FOR IMPROVING DRAINAGE OF JOR-BAG. AREA.

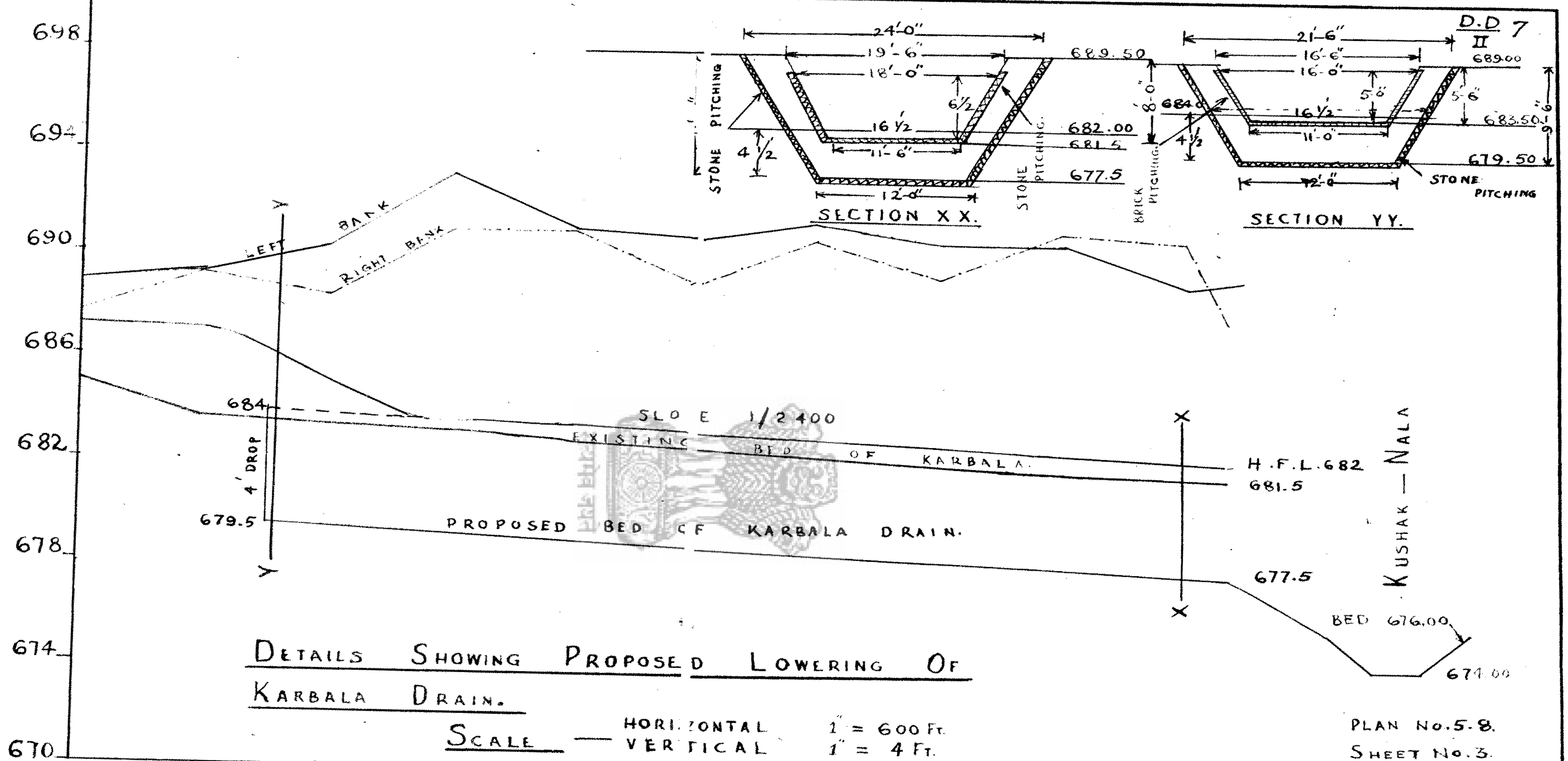
PROPOSALS.

1. K.L. BRICK PITCHED S.W. DRAIN FROM MADARSA CAPACITY 9 CUSECS FALL 1/800
2. R.C.C.-PIPE 4'-0" DIA. N.M. TO TAKE DISCHARGE OF AERODROME DRAIN RUNNING SOUTH TO NORTH.
3. PROPOSED DROP 4'-0" IN KARBALA DRAIN.
4. B.C. BARREL 50 FEET LONG TO PASS THE STORM WATER FROM JOR BAGH.
5. S.W. DRAIN SLOPE TO BE STEEPENED BY 1'-0" [BD]
6. 1 TO 5. FIVE CULVERTS TO BE DISMANTLED AND RECONSTRUCTED.
7. 4800' FEET OF EXISTING DRAIN TO BE DROPPED BY 4'-0" AVERAGE AND STONE PITCHED.



PLAN No. 5.2.
SHEET No. 2.

EXECUTIVE ENGINEER
DRAINAGE DIVISION



DETAILS SHOWING PROPOSED LOWERING OF KARBALA DRAIN.

SCALE — HORIZONTAL 1" = 600 Ft.
VERTICAL 1" = 4 Ft.

PLAN No. 5.8.
SHEET No. 3.

DISTANCES	0'	600'	1200'	1800'	2400'	3000'	3600'	4200'	4800'	5400'	5600'	6000'
BED OF DRAIN	685.07	683.69	683.40	683.16	682.82	[illegible]	682.30	682.02	681.72	681.59	681.50	
RIGHT BANK	687.68	689.24	688.33	690.97	691.02	690.88	690.68	689.24	691.04	690.70	681.61	
LEFT BANK	688.92	689.23	690.19	693.09	691.08	690.68	691.31	690.62	690.65	688.92	689.09	

S.M. Mistman
2.11.58

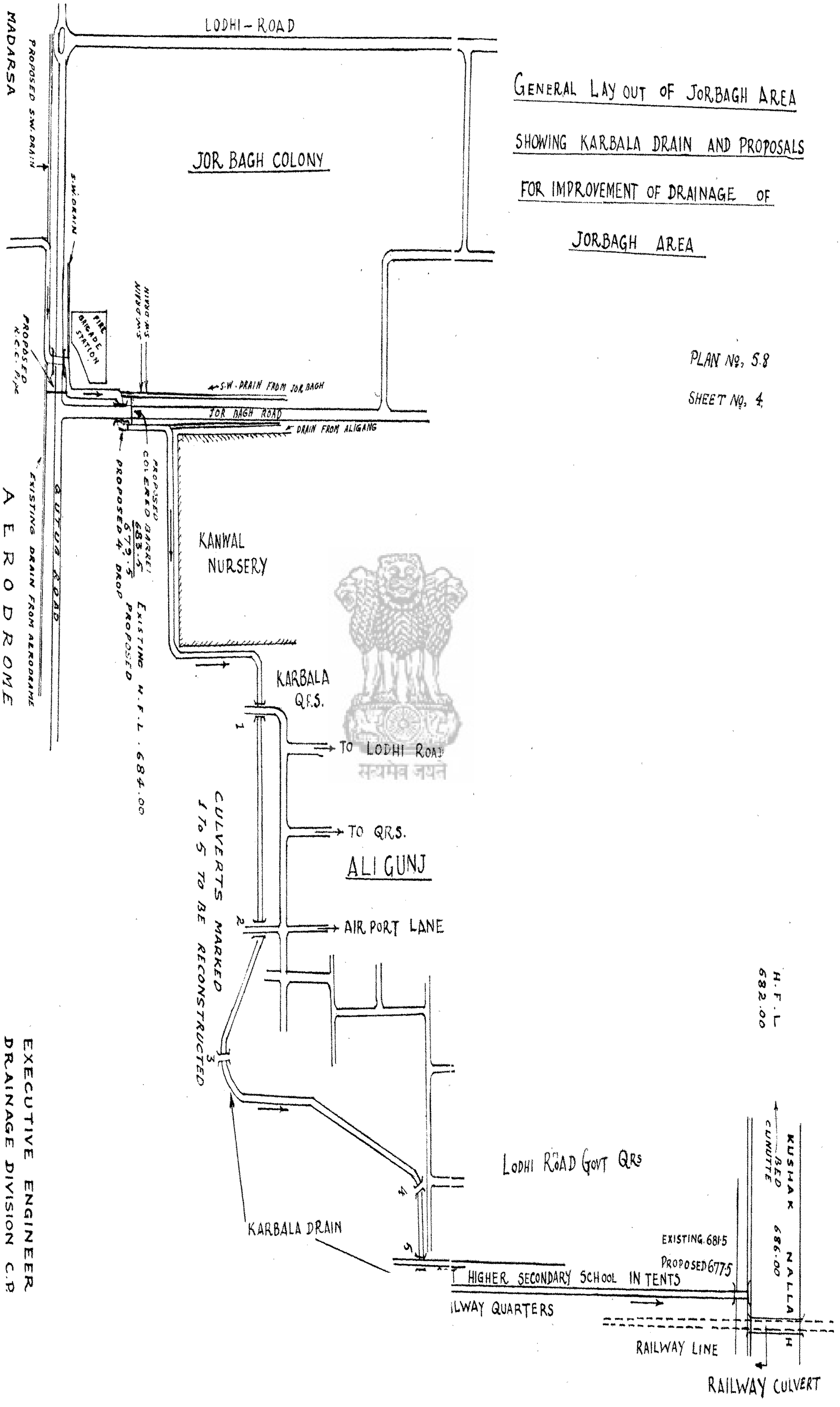
EXECUTIVE ENGINEER
DRAINAGE DIVISION
C.P.W.D NEW-DELHI.

K. ... Singh

GENERAL LAY OUT OF JORBAGH AREA SHOWING KARBALA DRAIN AND PROPOSALS FOR IMPROVEMENT OF DRAINAGE OF JORBAGH AREA

PLAN No. 5.8

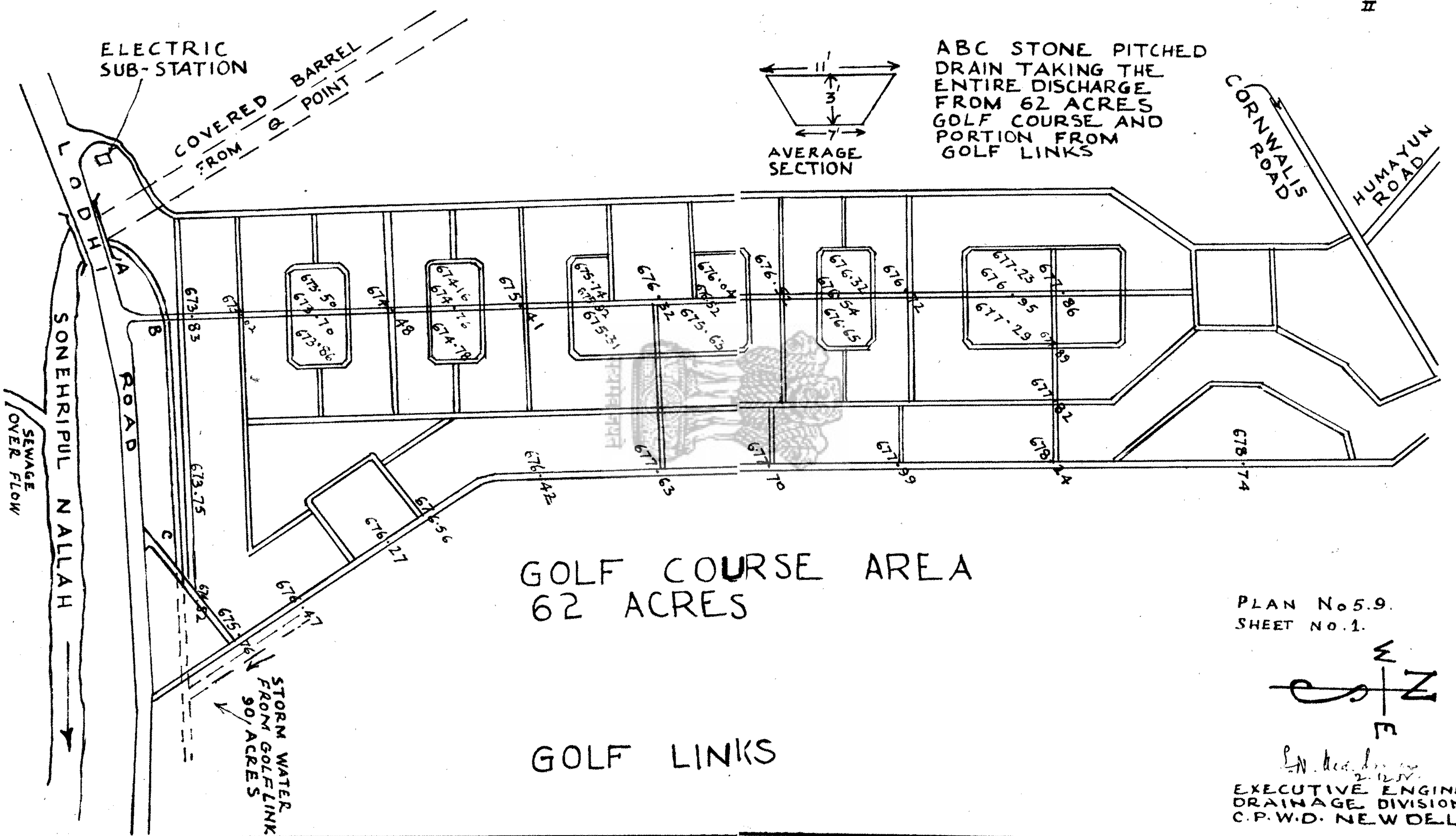
SHEET No. 4



EXECUTIVE ENGINEER
DRAINAGE DIVISION C.P.

सत्यमेव जयते

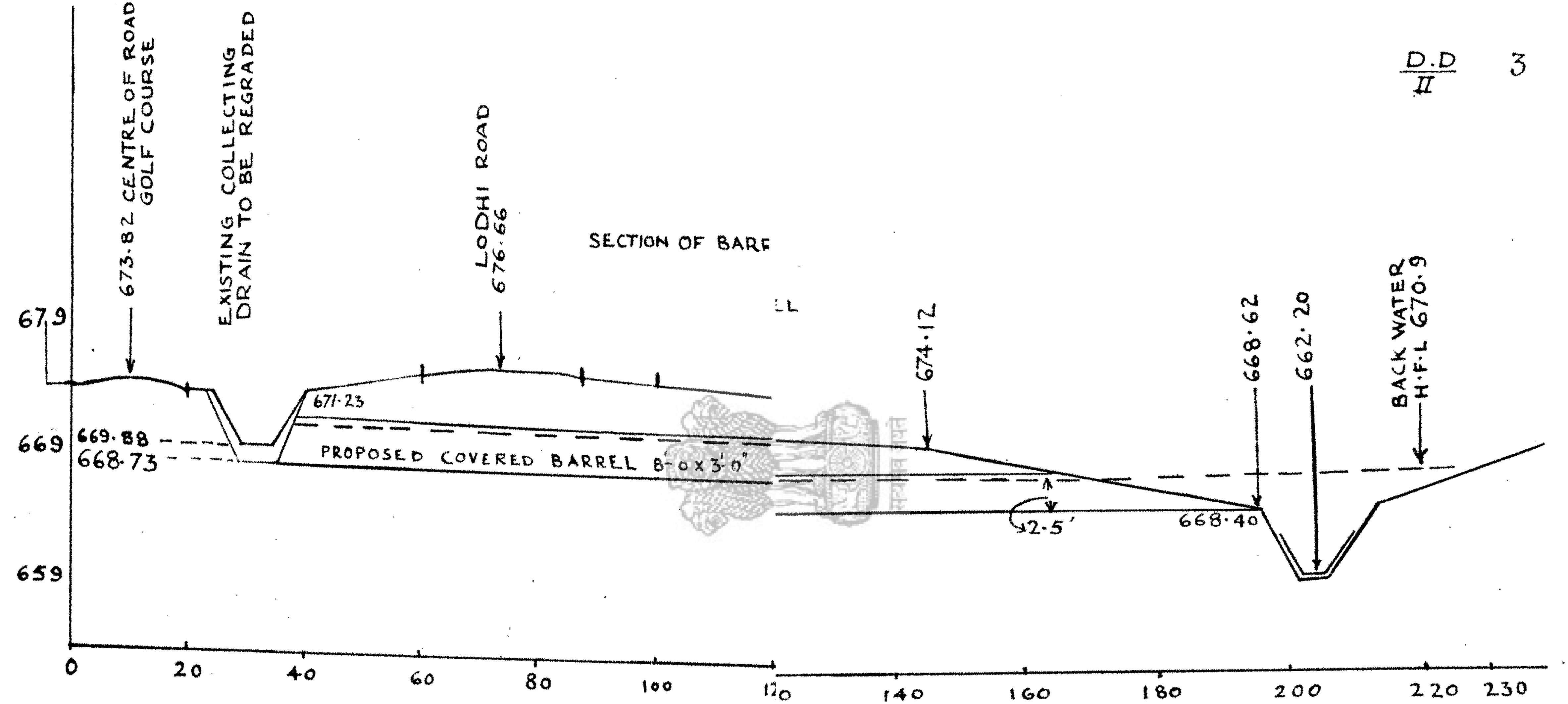
D.D/II 1



PLAN No 5.9.
SHEET No.1.

S.N. Mukherjee
2.12.57.
EXECUTIVE ENGINEER
DRAINAGE DIVISION
C.P.W.D. NEW DELHI.

$\frac{\text{D.D}}{\text{II}}$ 3



L.5 PROPOSED CROSS DRAIN ACROSS LODHI ROAD TO TAKE GOLF COURSE STORM WATER TO SONERIPUL NALLAH.

SCALE
HORIZONTAL 1" = 20'
VERTICAL 1" = 10'

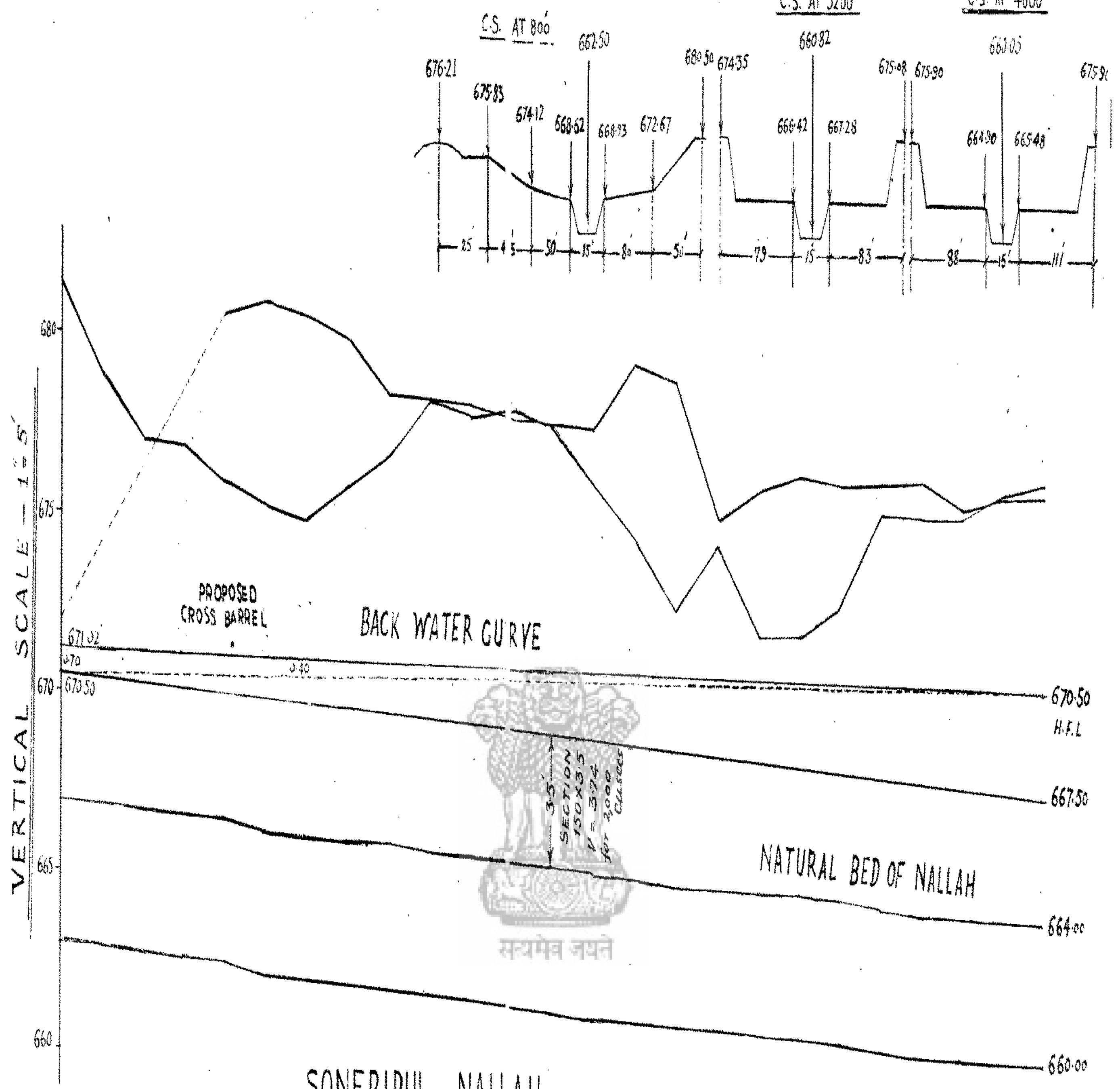
PLAN No.5.9.
SHEET No.2.

S.N. Lakshman
2.12.08

EXECUTIVE ENGINEER
DRAINAGE DIVISION
C.P.W.D. NEW DELHI.

D.D
II 4

L. SECTION OF SUNERIPUL NALLAH



SONERIPUL NALLAH

DISTANCE	0	200'	400'	600'	800'	1000'	1200'	1400'	1600'	1800'	2000'	2200'	2400'	2600'	2800'	3000'	3200'	3400'	3600'	3800'	4000'	4200'	4400'	4600'	4800'	5000'
TOP OF LEFT BANK	681.42	678.86	677.05	676.84	675.80	675.15	674.90	675.10	676.60	678.16	677.87	678.04	677.65	675.98	674.50	672.56	674.35	671.68	671.90	672.70	675.33	675.31	675.22	675.89	676.21	
TOP OF RIGHT BANK					680.50	680.80	680.50	673.40	678.38	678.31	678.14	677.80	677.67	677.61	679.34	678.94	675.08	675.90	676.43	676.12	676.16	676.20	675.56	675.92	675.93	
NATURAL BED	667.[illegible]	666.90	666.70	666.58	666.50	666.10	666.01	665.90	665.80	665.66	665.53	665.43	665.36	665.06	665.01	664.90	664.82	664.78	664.72	664.53	664.41	664.20	664.15	664.05	664.00	
BED OF CUNETTE	663.[illegible]	662.90	662.70	662.58	662.50	662.10	662.01	661.90	661.80	661.66	661.53	661.43	661.36	661.06	661.01	660.90	660.82	660.78	660.72	660.53	660.41	660.20	660.15	660.05	660.00	

HORIZONTAL SCALE - 1" = 400

PLAN No. 5.9
SHEET No. 3.

2.12.81
EXECUTIVE ENGINEER
DRAINAGE DIVISION

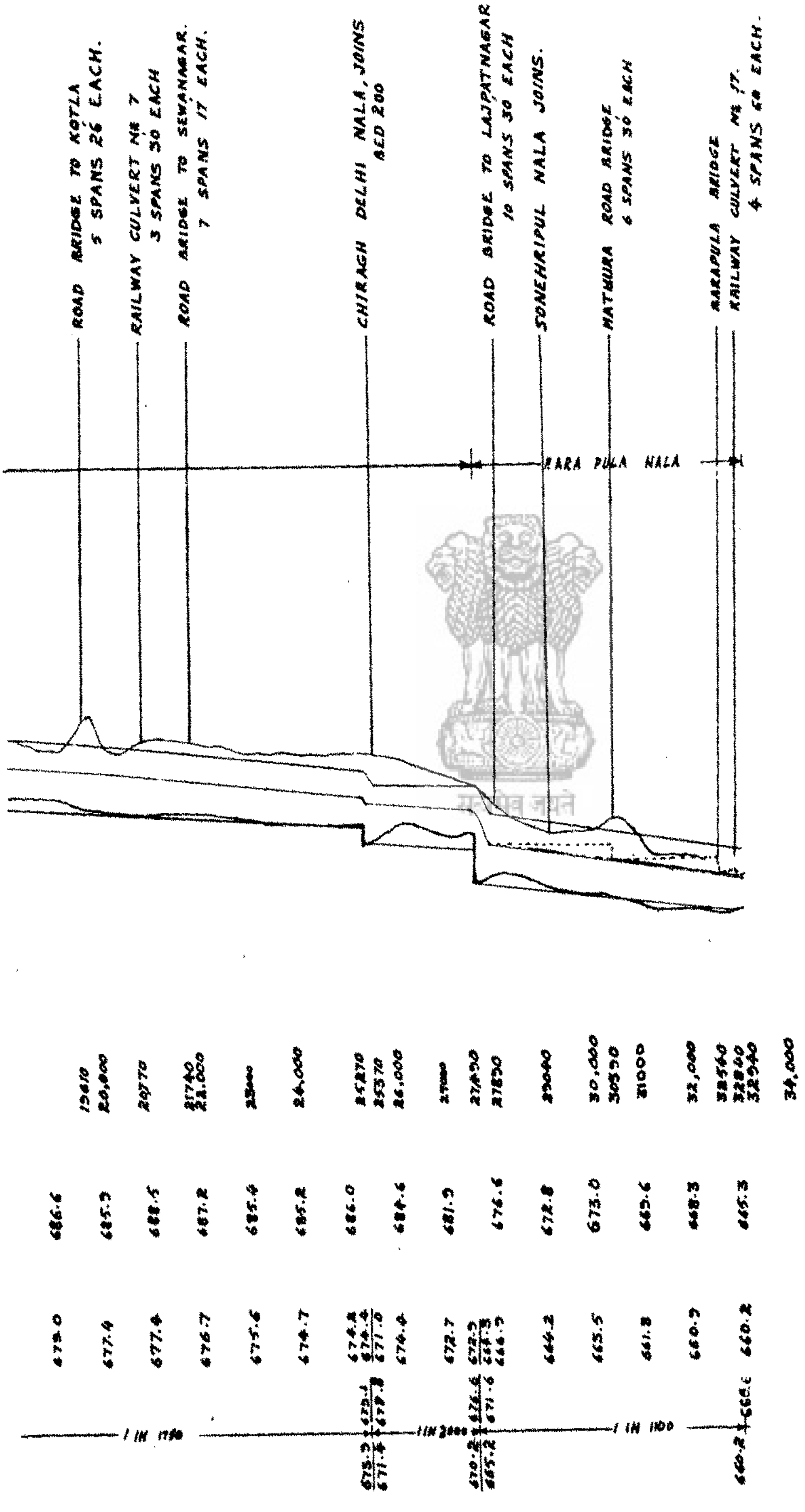
PLAN No. 311

ION

RAPULA NALAS

DRG No:–
EE. D/1/1/KUSHAKNALA
L-SECTION

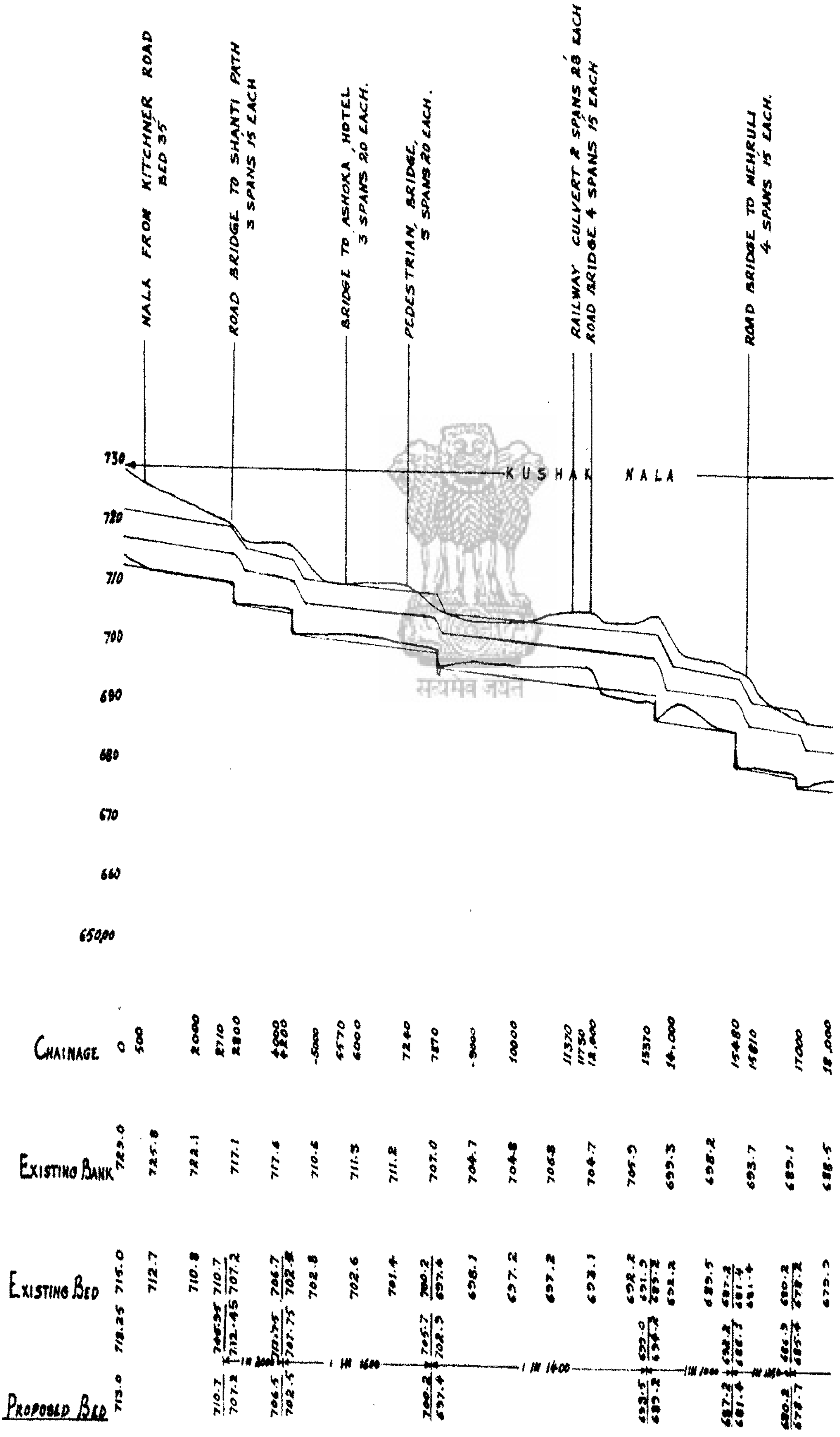
Horizontal 4000' = 1"
Scale – Vertical 40' = 1"



(S.K. KRISHNAN)
Executive Engineer
Drainage Division
C.P.W.D New Delhi.

L-SECT

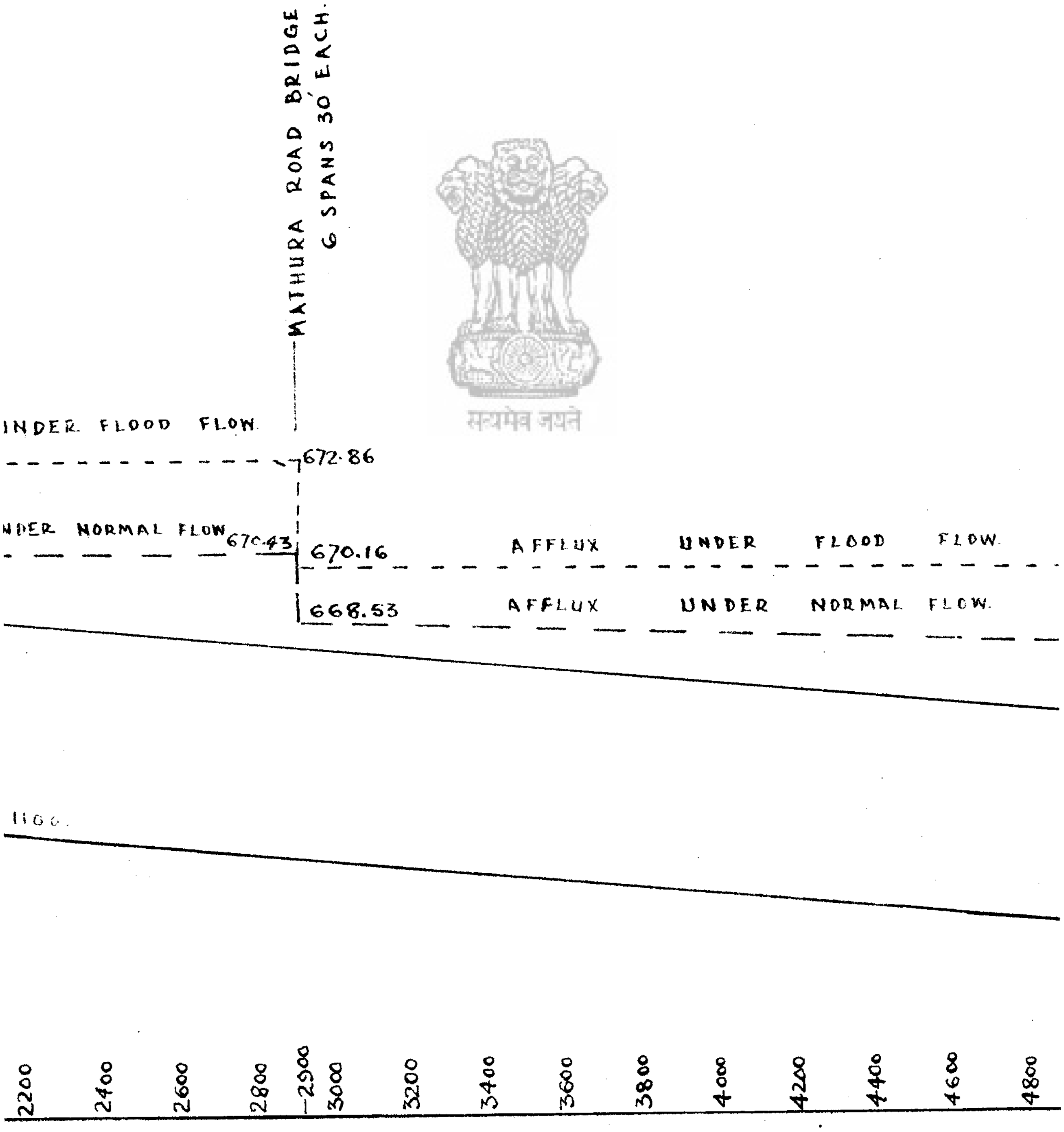
KUSHAKE BA



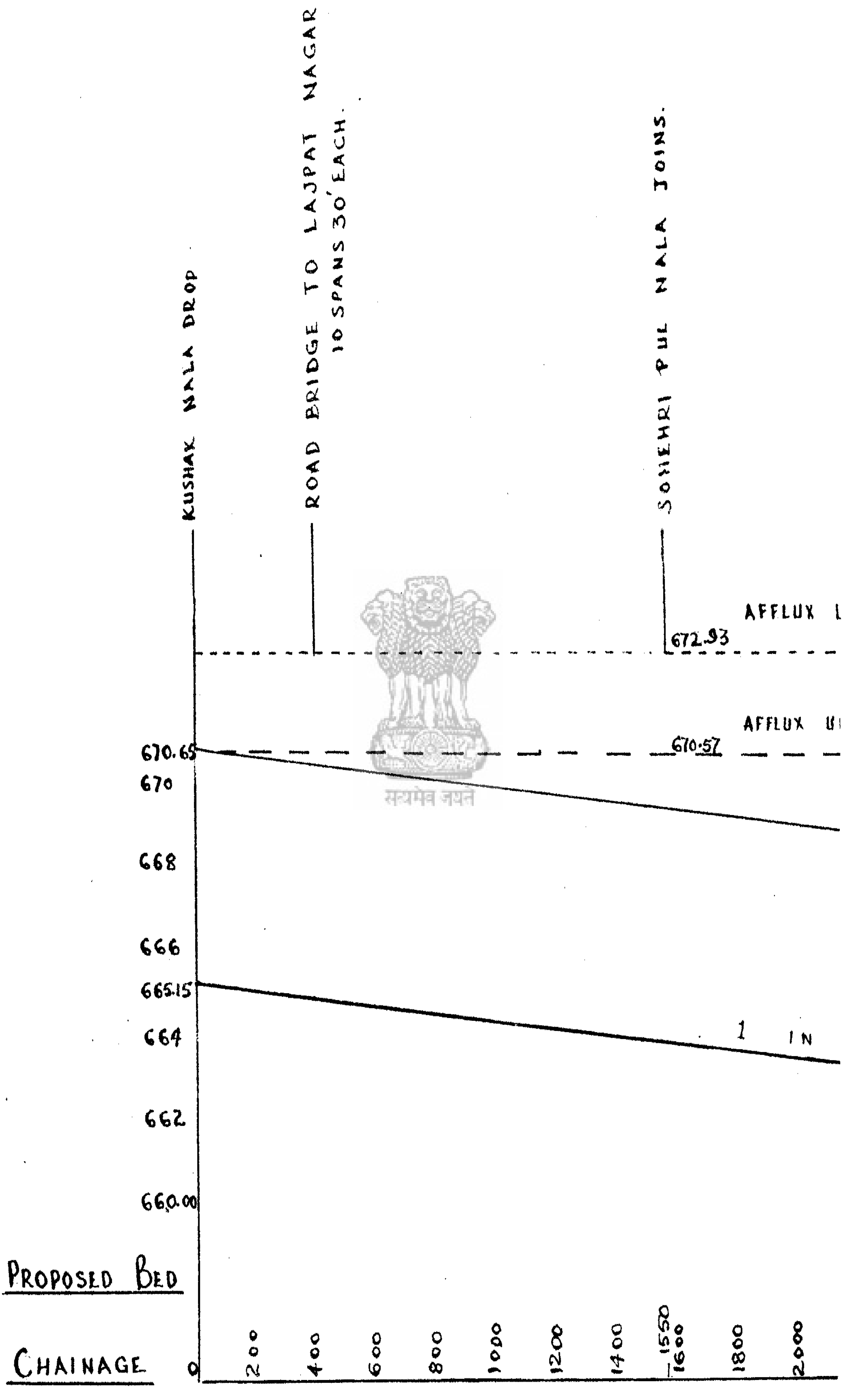
L SECTION

BARAPULA NALA

SCALE — HORIZONTAL 400′ = 1″
VERTICAL = 4′ = 1″

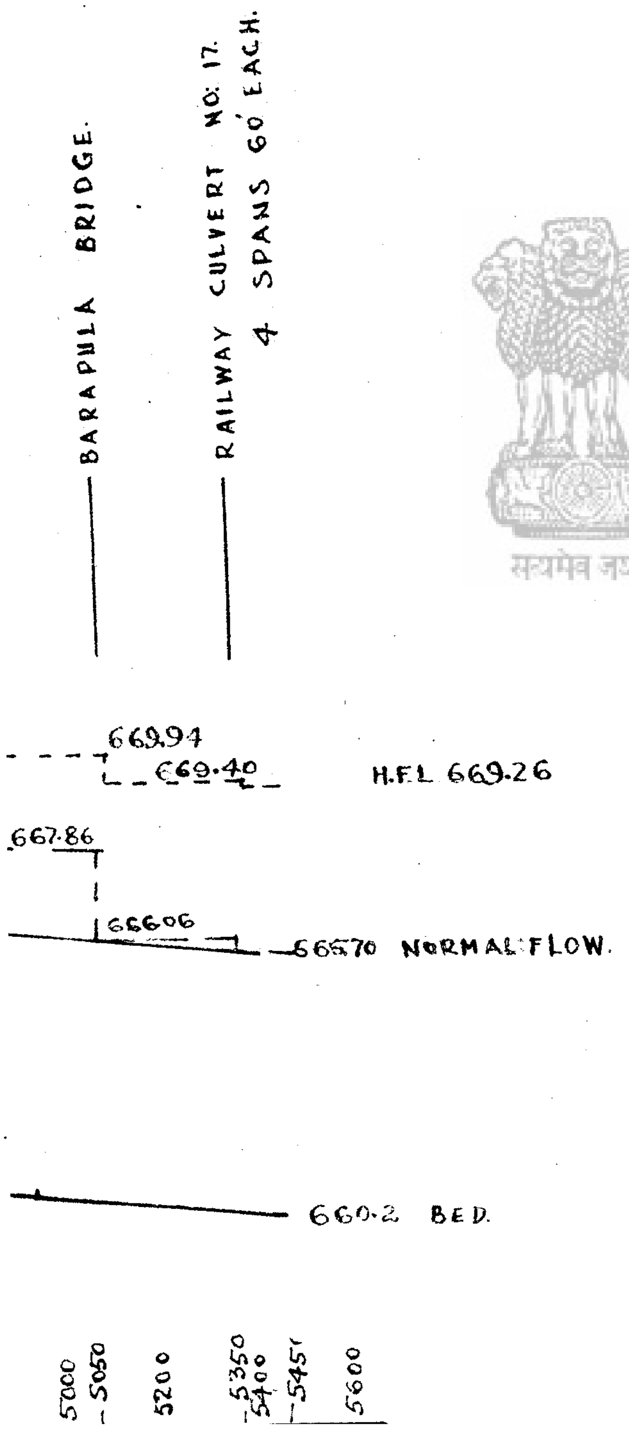


सत्यमेव जयते


KUSHAK NALA DROP
ROAD BRIDGE TO LAJPAT NAGAR
10 SPANS 30' EACH.
SOHEHRI PUL NALA JOINS.
AFFLUX
672.93
AFFLUX
670.65
670.57
670
668
666
665.15
664
662
660.00
1 IN
PROPOSED BED
CHAINAGE
0
200
400
600
800
1000
1200
1400
1550
1600
1800
2000

DRNG. No. – DRAINAGE 1|3

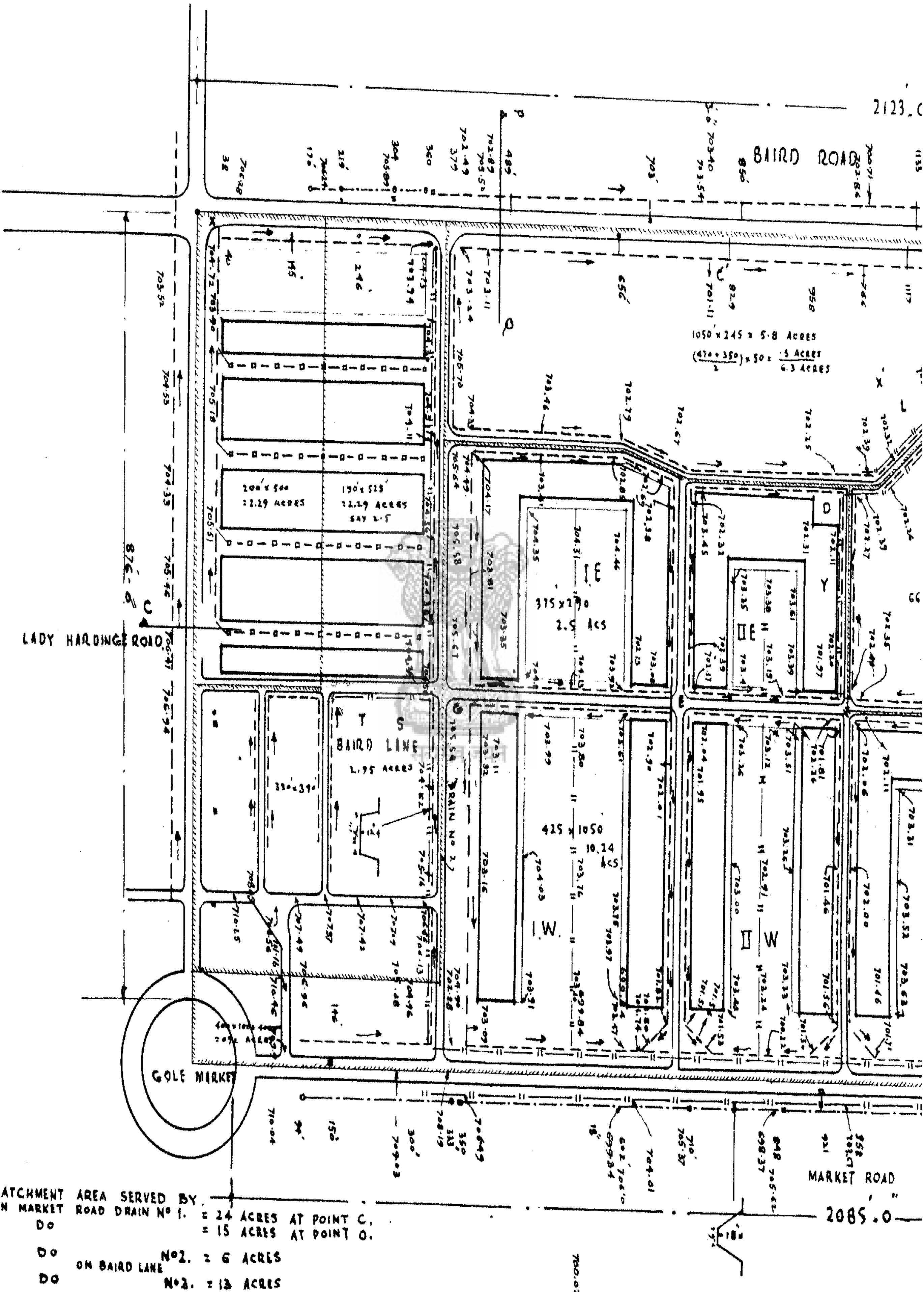
PLAN No. 5.12
SHEET No. 2



सत्यमेव जयते

(S.N. KRISHNAN)
EXECUTIVE ENGINEER
DRAINAGE DIVISION
C.P.W.D NEW DELHI.

PLAN OF MAR

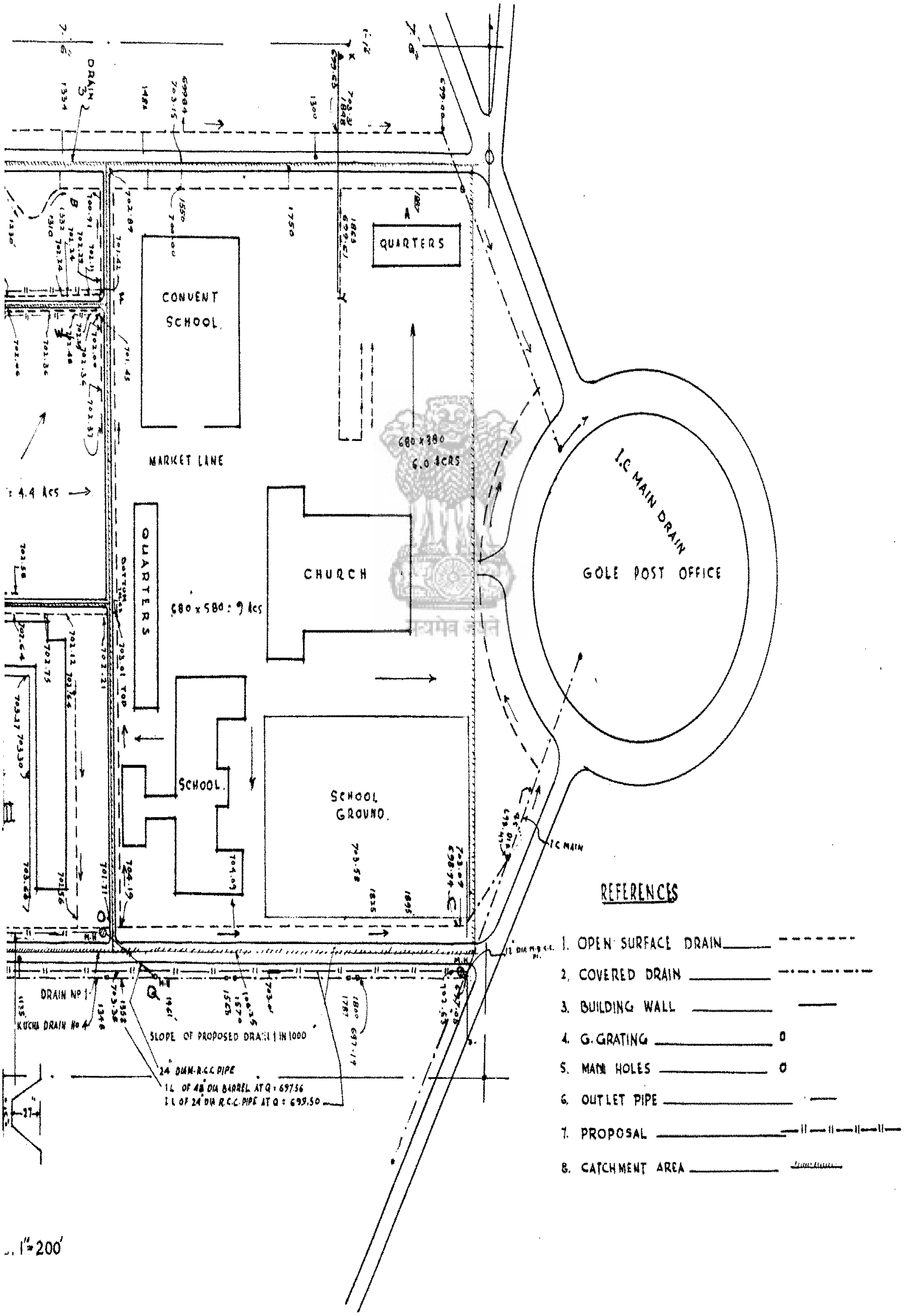


1. CATCHMENT AREA SERVED BY
ON MARKET ROAD DRAIN Nº 1. = 24 ACRES AT POINT C.
2. DO = 15 ACRES AT POINT O.
3. DO ON BAIRD LANE Nº2. = 6 ACRES
4. DO Nº3. = 13 ACRES AT POINT B.
5. DO = 25 ACRES AT POINT A.
6. DO ON MARKET ROAD Nº 4. = 9 ACRES

HOR. S

DRAWING SHEET No 1
PLAN No 5.13

ROAD AREA

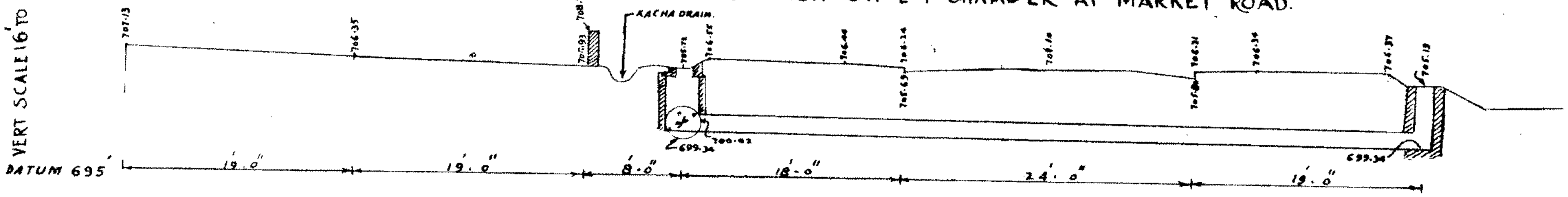


REFERENCES

1. OPEN SURFACE DRAIN ------
2. COVERED DRAIN -·-·-·-
3. BUILDING WALL ——
4. G. GRATING O
5. MAN HOLES O
6. OUTLET PIPE ——
7. PROPOSAL —||—||—||—
8. CATCHMENT AREA ▨

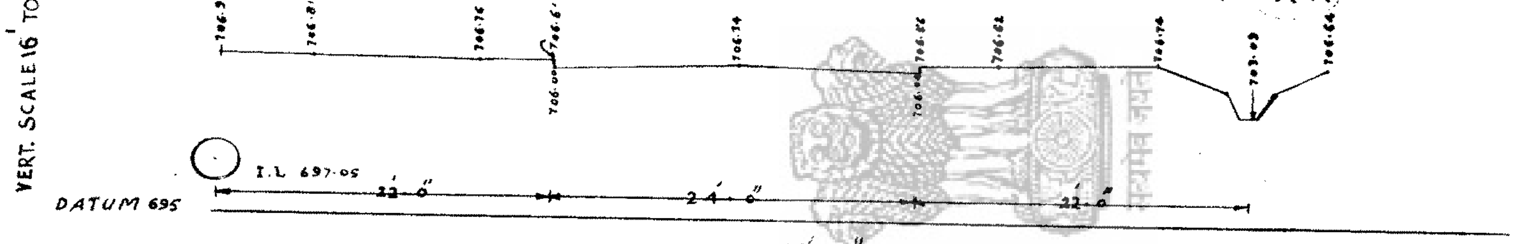
SHEET NO. 3
PLAN NO. 5.13

SECTION ON E-F CHAMBER AT MARKET ROAD.



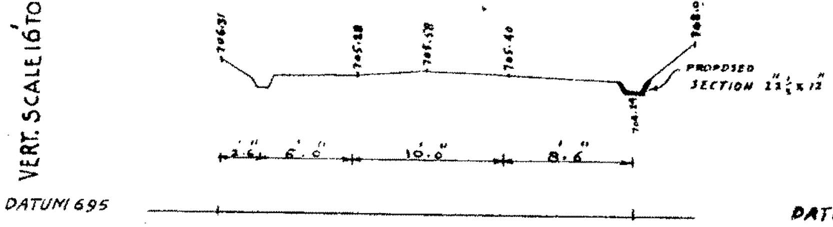
HOR. SCALE 16' TO 1"

SECTION AT THE END OF MARKET ROAD A-A'



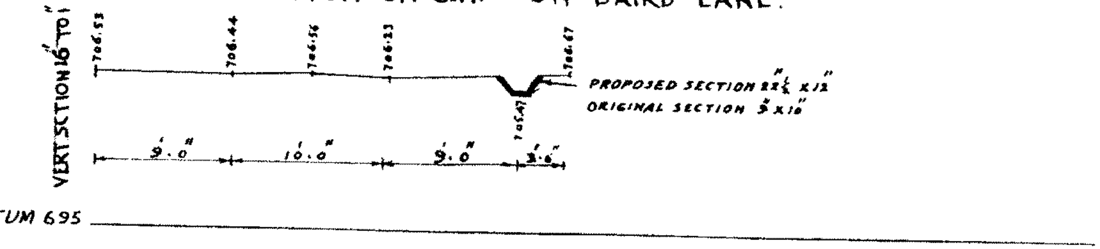
HOR. SCALE 16' TO 1"

SECTION ON A.B. ON BAIRD LANE



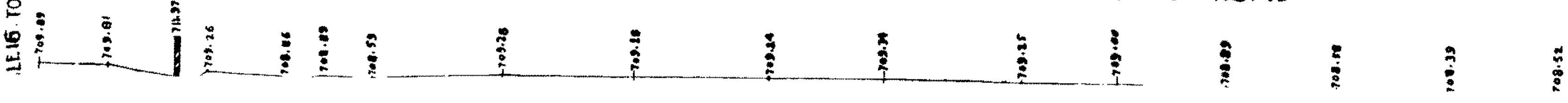
HOR. SCALE 16' TO 1"

SECTION ON G.H. ON BAIRD LANE.



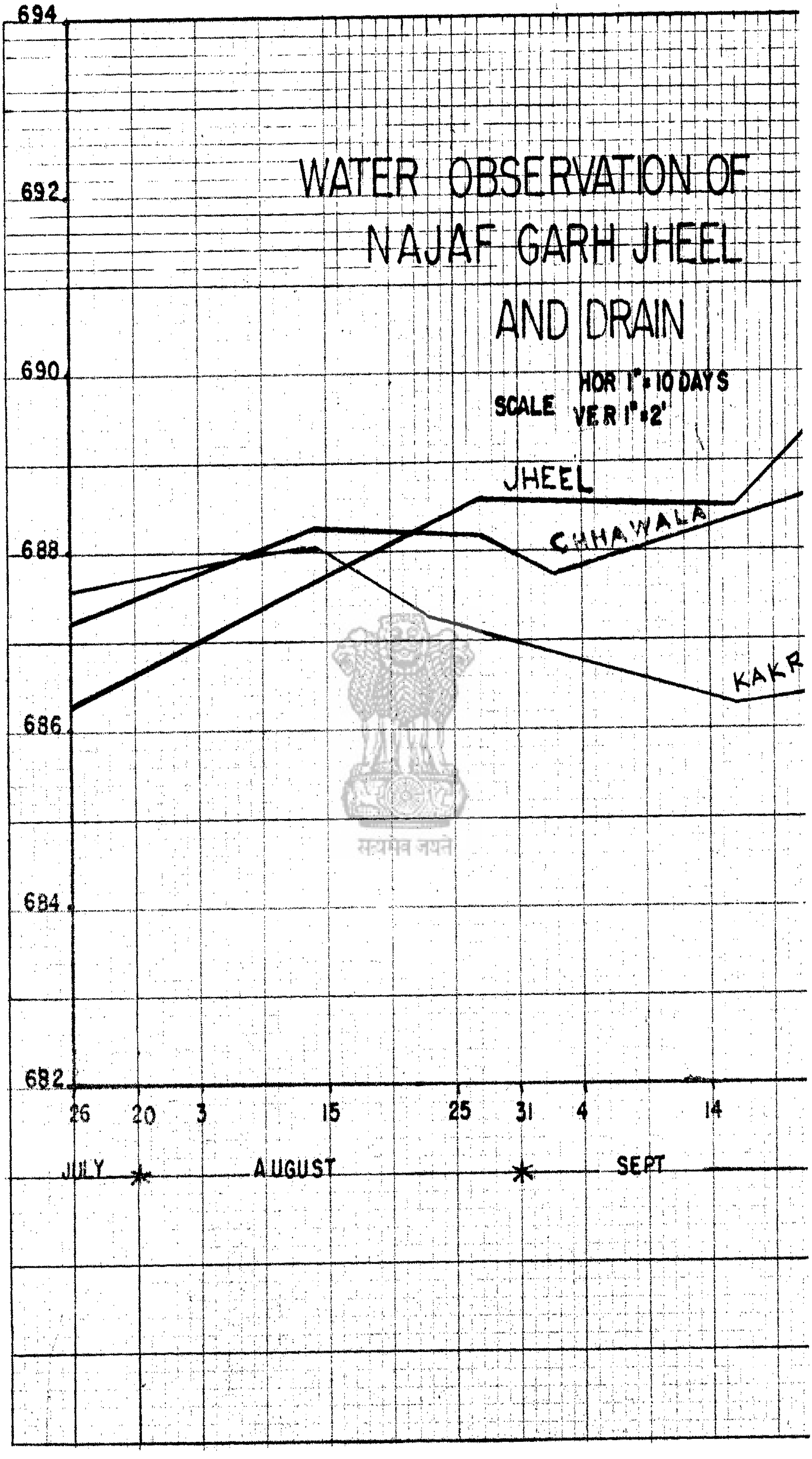
HOR. SCALE 16' TO 1"

SECTION ON C-D ON LADY HARDINGE. ROAD.



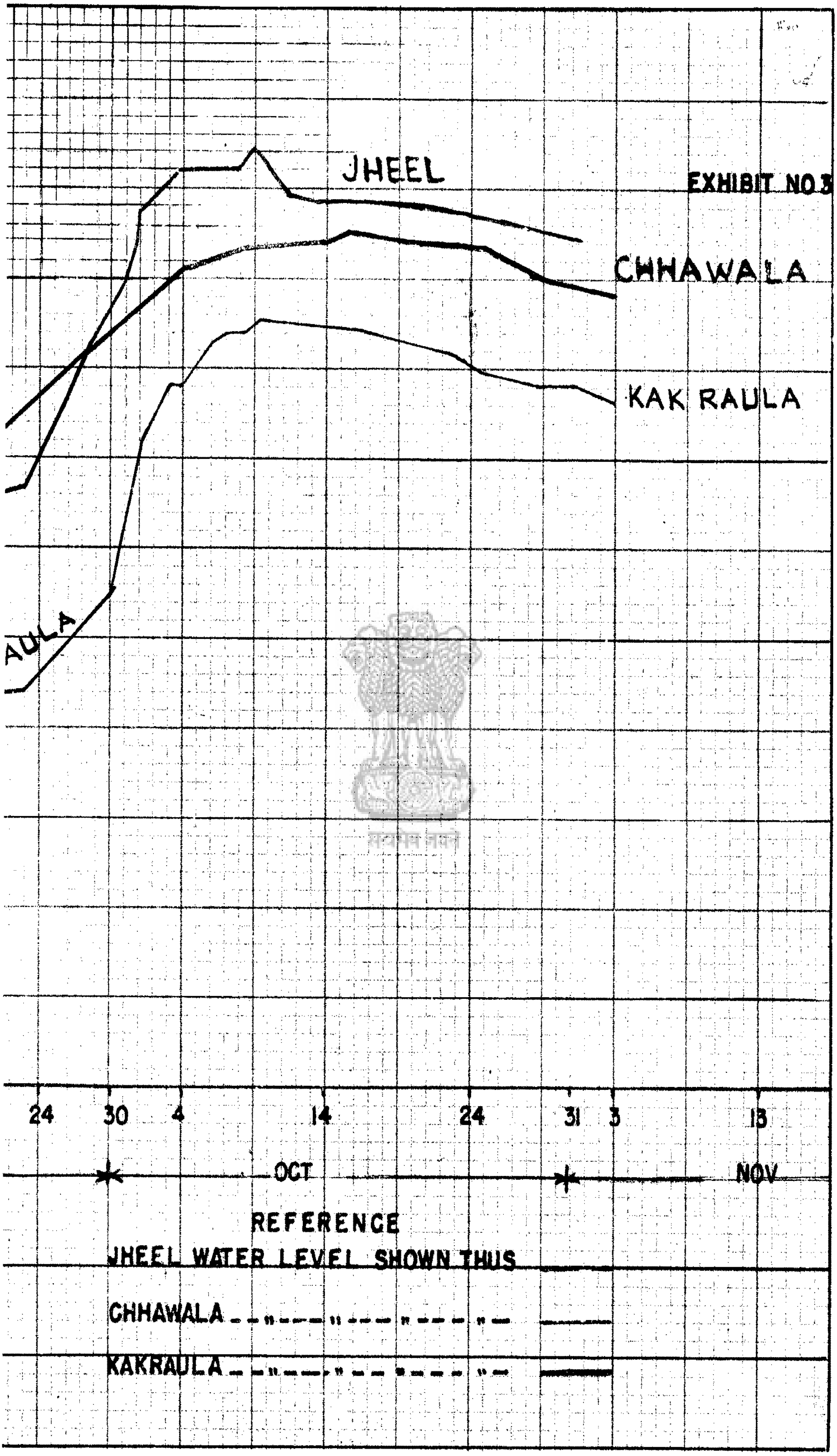
PLANS REFERRED TO IN APPENDIX IV

सत्यमेव जयते


WATER OBSERVATION OF
NAJAF GARH JHEEL
AND DRAIN
SCALE HOR 1" = 10 DAYS
VER 1" = 2'
JHEEL
CHHAWALA
KAKR
694
692
690
688
686
684
682
26
20
3
15
25
31
4
14
JULY
AUGUST
SEPT

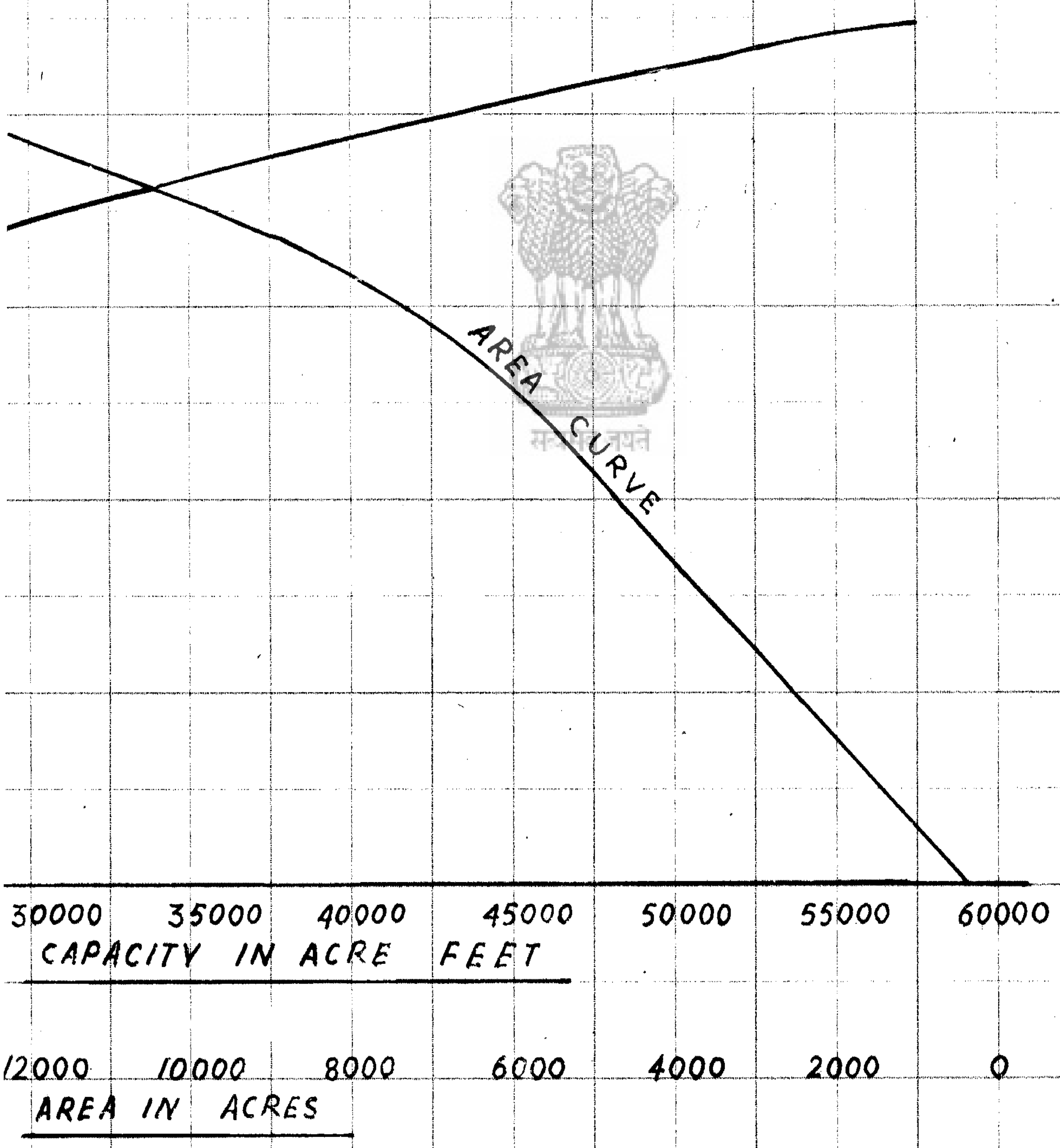
सत्यमेव जयते

EXHIBIT NO 3


JHEEL
CHHAWALA
KAK RAULA
AULA
24
30
4
14
24
31
3
13
OCT
NOV
REFERENCE
JHEEL WATER LEVEL SHOWN THUS
CHHAWALA — " — " — " — "
KAKRAULA — " — " — " — "

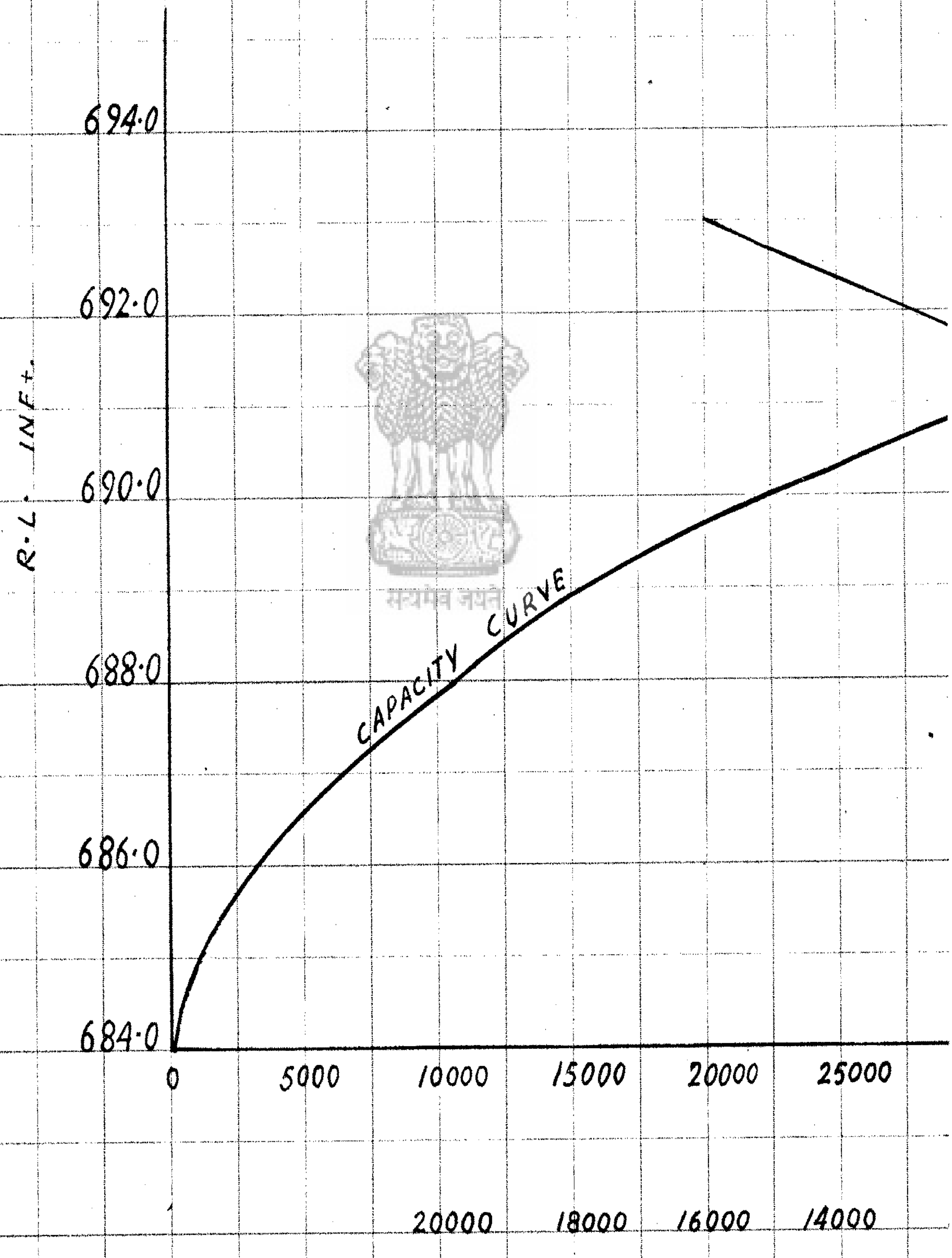
CAPACITY CURVE

FOR
GARH JHIL
BASIN AREA

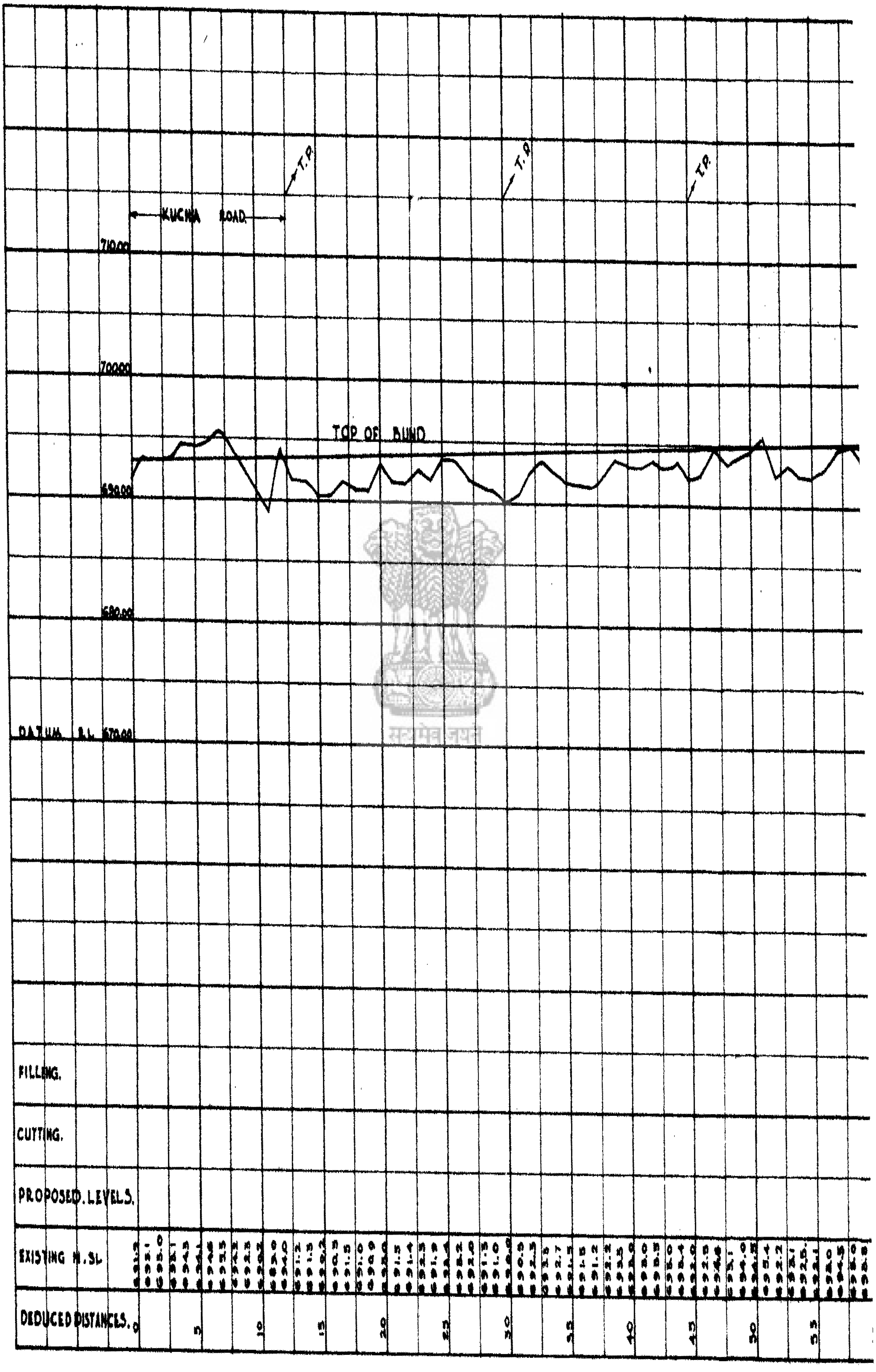


AREA AND

NAJA



L-SECTION OF


T.P.
T.P.
T.P.
KUCHA ROAD
710.00
700.00
TOP OF BUND
690.00
680.00
DATUM R.L. 670.00
FILLING.
CUTTING.
PROPOSED. LEVELS.
EXISTING N. SL.
DEDUCED DISTANCES.
0
5
10
15
20
25
30
35
40
45
50
55

BUND No 1

EXHIBIT No 8.

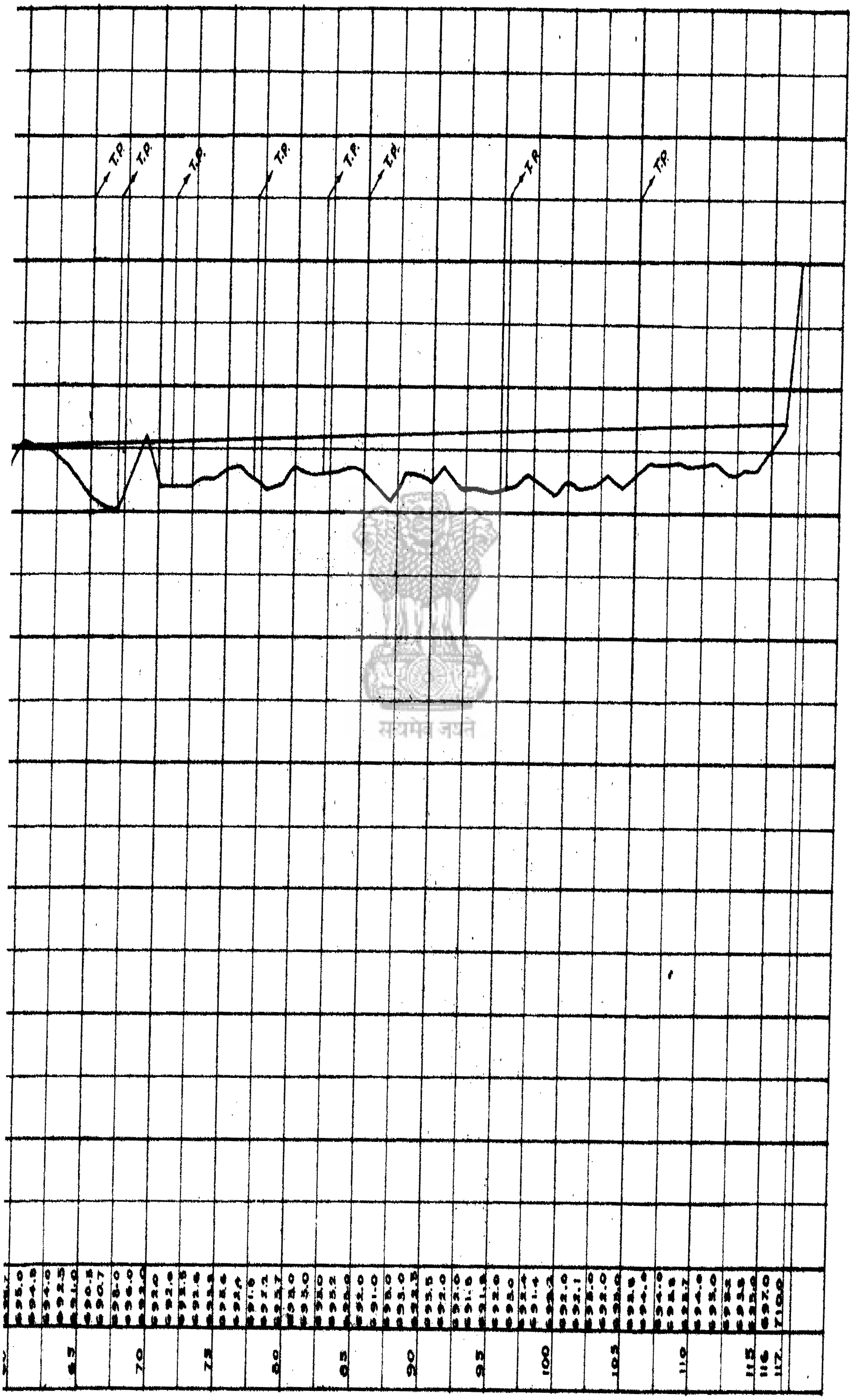
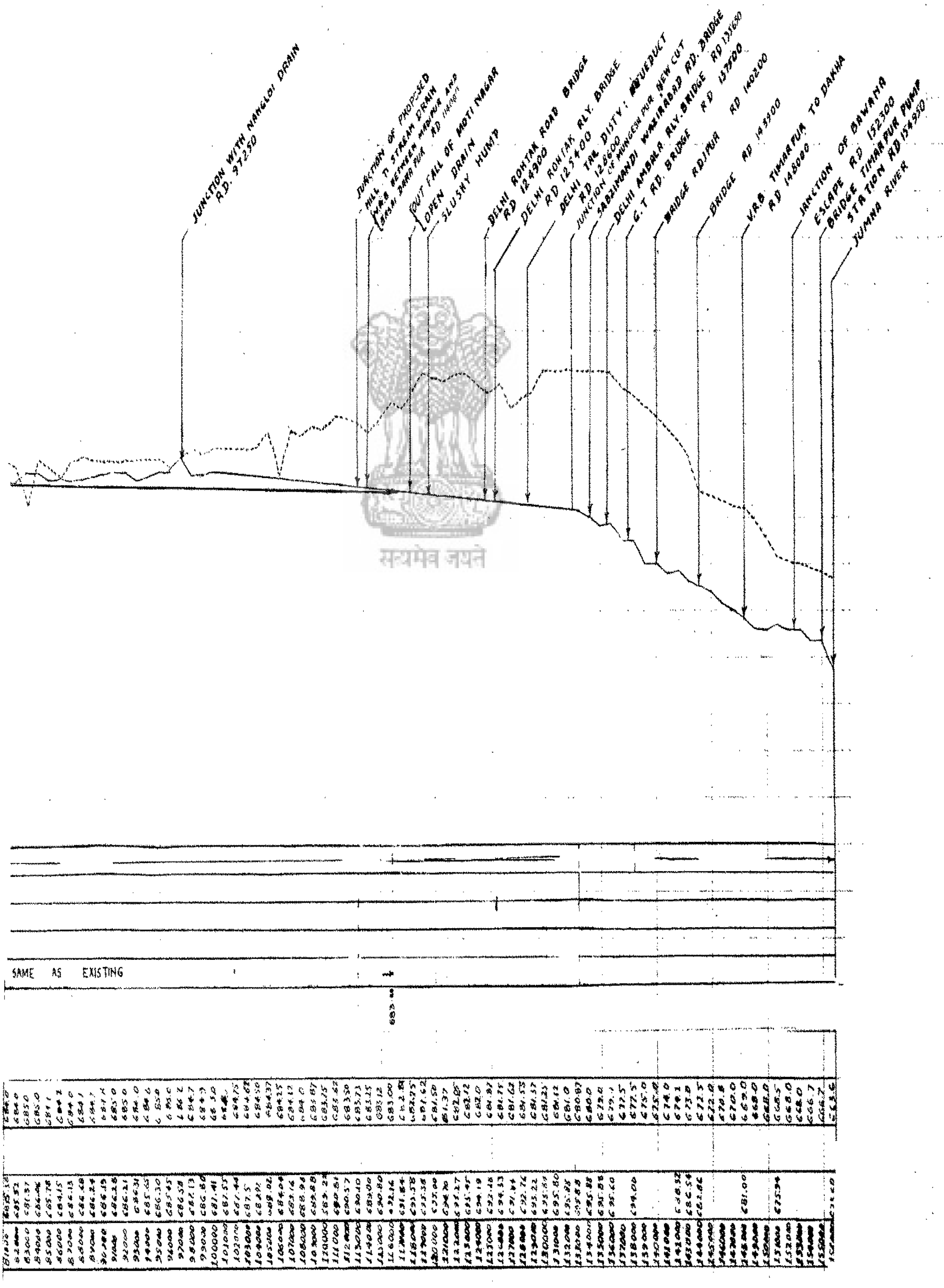
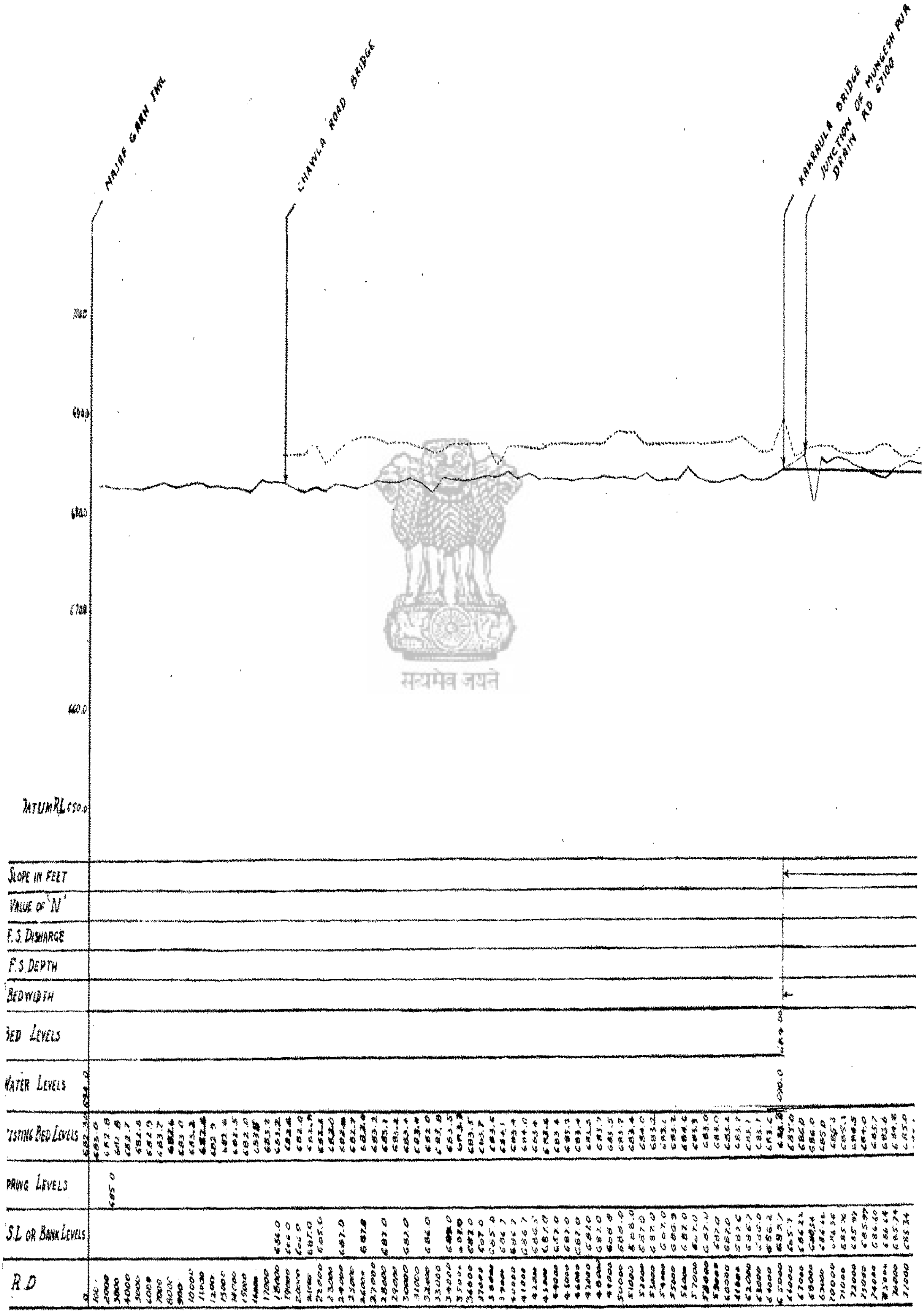


EXHIBIT No. 5


JUNCTION WITH NANGLOI DRAIN RD. 97250
JUNCTION OF PROPOSED
MILL T1 STREAM DRAIN
W.R.B BETWEEN MADIPUR AND BASAI DARA PUR RD 114000
OUT FALL OF MOTI NAGAR
OPEN DRAIN
SLUSHY HUMP
DELHI ROHTAK ROAD BRIDGE RD 124900
DELHI ROHTAK RLY. BRIDGE RD 125400
DELHI TAL DISTY. AQUEDUCT RD 128600
JUNCTION OF MUNGESH PUR NEW CUT
SABZIMANDI WAZIRABAD RD. BRIDGE RD 133650
DELHI AMBALA RLY. BRIDGE RD 137500
G.T RD. BRIDGE
BRIDGE RDJPUR RD 140200
BRIDGE RD 143900
V.R.B. TIMARPUR TO DAKHA RD 148000
JUNCTION OF BAWANA ESCAPE RD 152300
BRIDGE TIMARPUR PUMP STATION RD 154950
JUMNA RIVER
SAME AS EXISTING
683.00

L. SECTION OF NAJAF GARH DRAIN

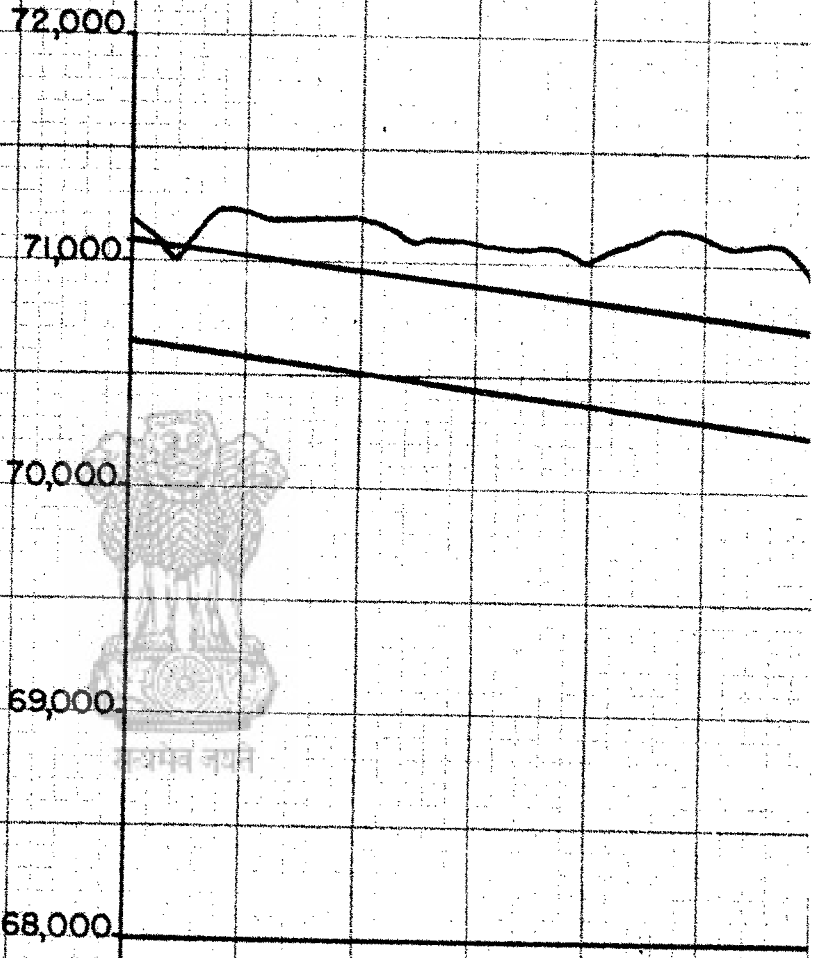
SCALE { HOR 1" = 10,000'
VERT 1" = 20 FT.



L. SECTION OF M

FROM ORIGIN U

SCALE {H
{VE



SLOPE IN FT. ← 1 IN
VALUE OF N ← N
A.S.F. DISCHARGE
F.S. DEPTH ← 4·
BED WIDTH ← 26

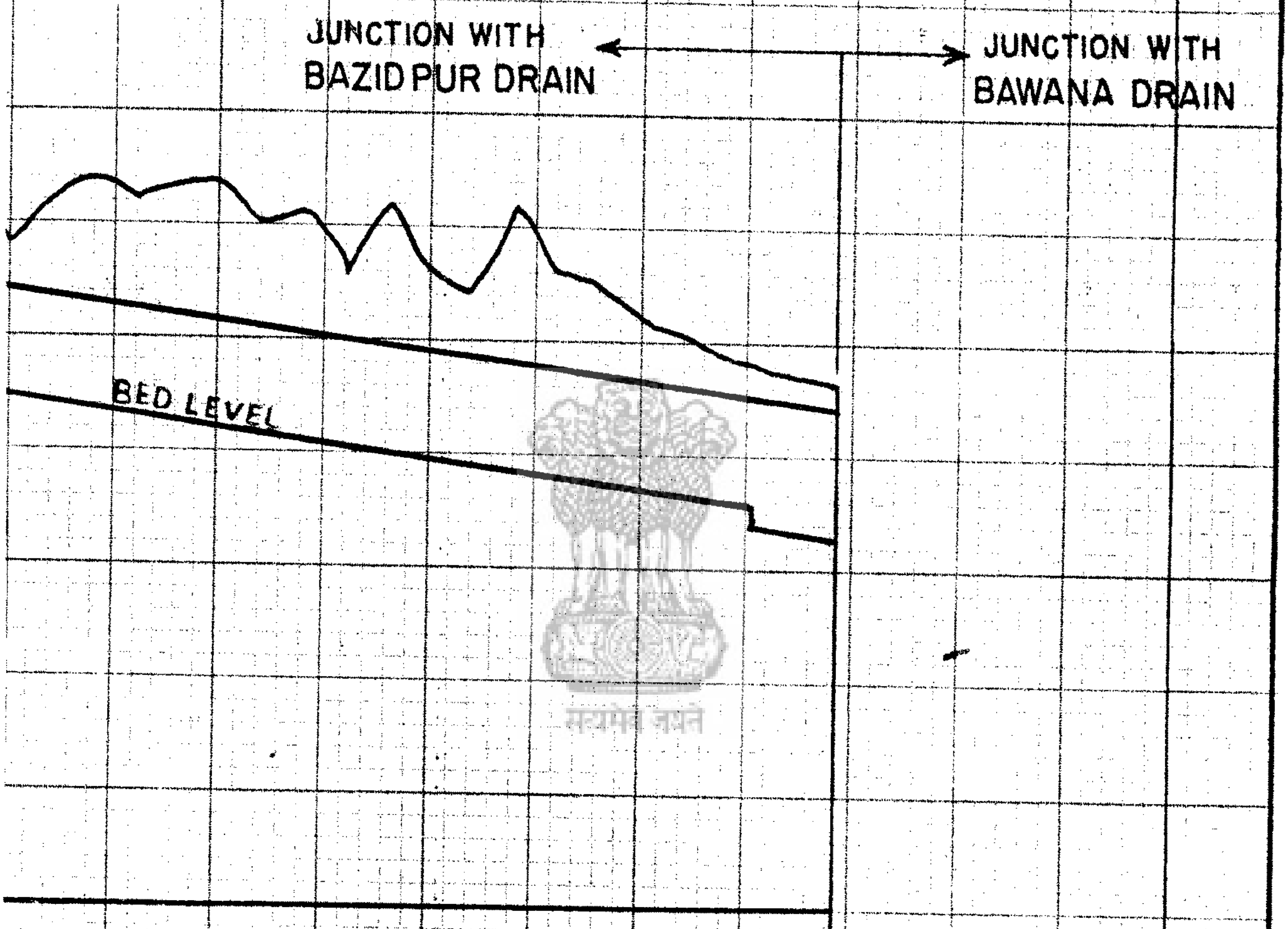
R.D.	0	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11	12.	13.	14.	15.
F.S. LEVELS	710.5				709.5				708.5				707.5			
BED LEVELS	706.00	705.75	705.50	705.25	705.00	704.75	704.50	704.25	704.00	703.75	703.50	703.25	703.00	702.75	702.50	702.25
N.S. LEVELS	711.20	709.90	711.80	711.20	711.40	711.40	710.30	710.70	710.30	710.20	710.00	710.80	711.10	710.30	710.80	708.70

EXHIBIT No 10.

ANGESHPUR DRAIN

TO NEW CUT

R: 1" = 4000 FT.
RT: 1" = 10 FT.



सत्यमेव जयते

4000

0·02

FT. 5·3

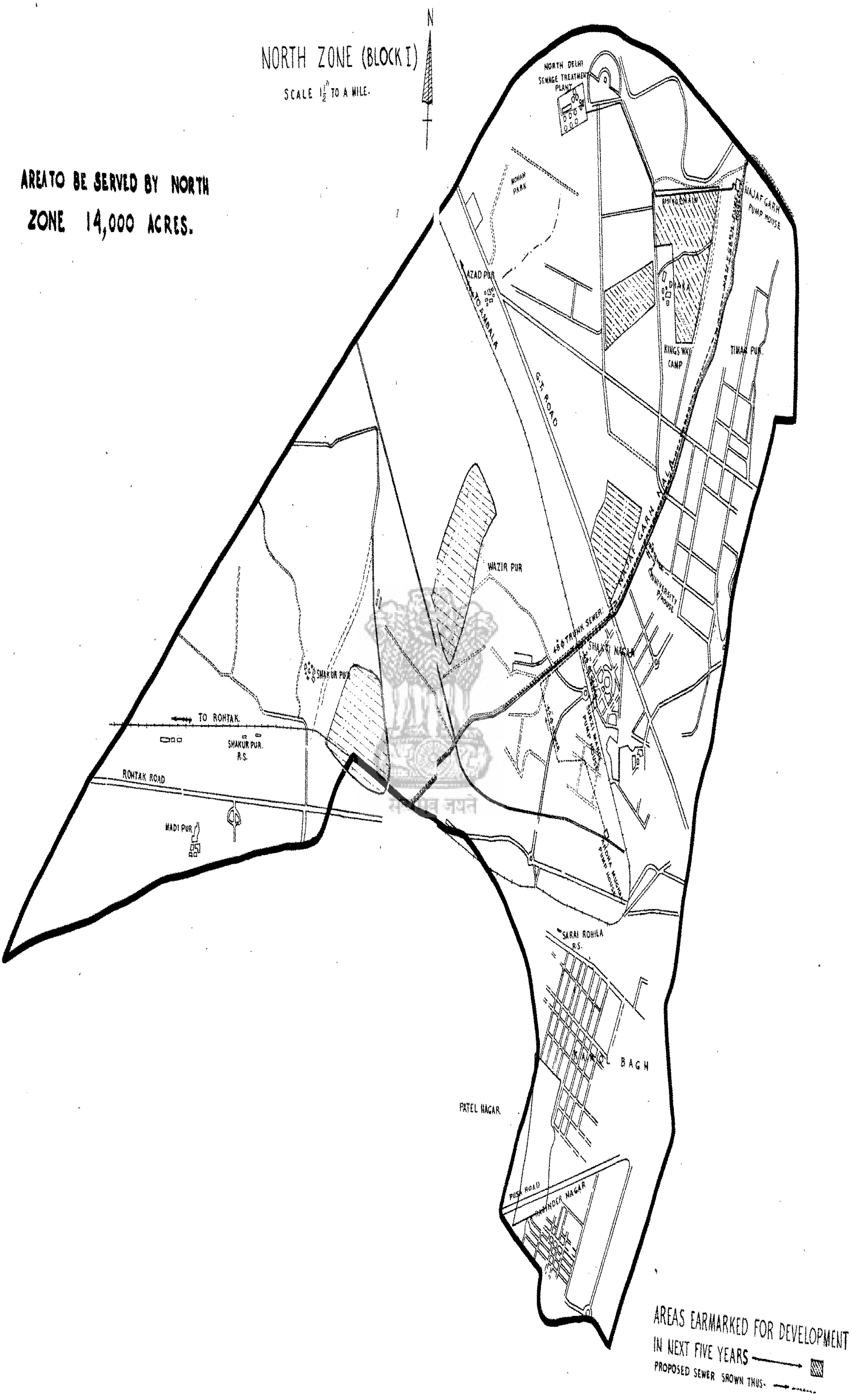
FEET

16.	710·80	702.00	706·5
17.	711·70	701.75	
18.	710.80	701.50	
19.	711.30	701.25	
20.	711.20	701.00	705.5
21.	709.50	700·75	
22.	710.30	700·50	
23.	707.30	700·25	
24.	710·20	700·00	704·5
25.	707.30	699.75	
26	706·70	699·50	
27.	710·30	699·25	
28.	707·50	699·00	703·5
29.	707·00	698·75	
30.	705·60	698·50	
31	704·70	698·25	
32.	704·00	698·00	702·5
33.	704·20	697·35	
34.	704.00	696.57	
		696.07	701·37

NORTH ZONE (BLOCK I)

SCALE 1½" TO A MILE.

AREA TO BE SERVED BY NORTH ZONE 14,000 ACRES.



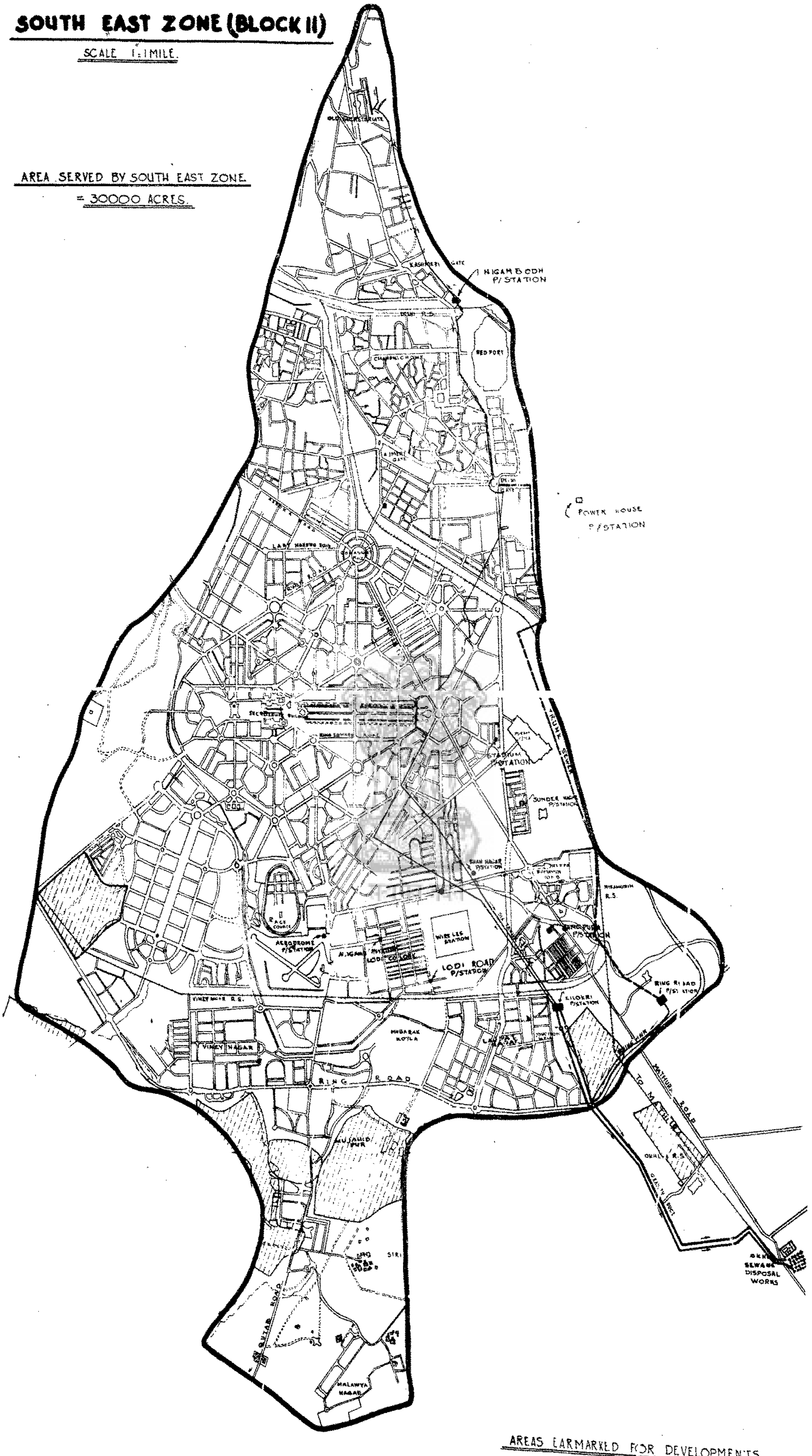
AREAS EARMARKED FOR DEVELOPMENT IN NEXT FIVE YEARS ⟶ ▨

PROPOSED SEWER SHOWN THUS- ⟶

SOUTH EAST ZONE (BLOCK II)

SCALE 1"=1MILE.

AREA SERVED BY SOUTH EAST ZONE
= 30000 ACRES.



AREAS EARMARKED FOR DEVELOPMENTS
IN NEXT 5 YEARS ---- ▨

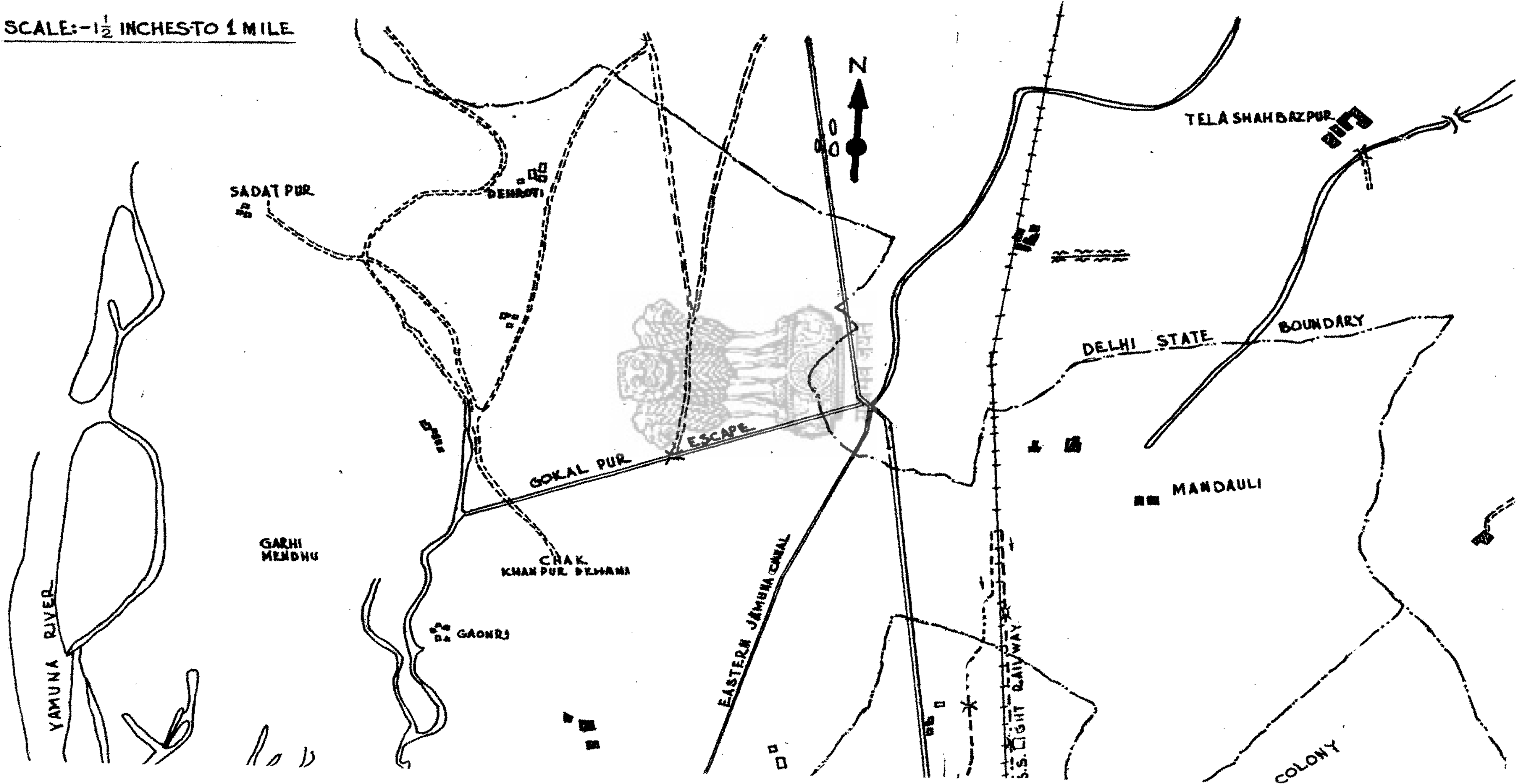
PROPOSED SEWER IS SHOWN THUS ------

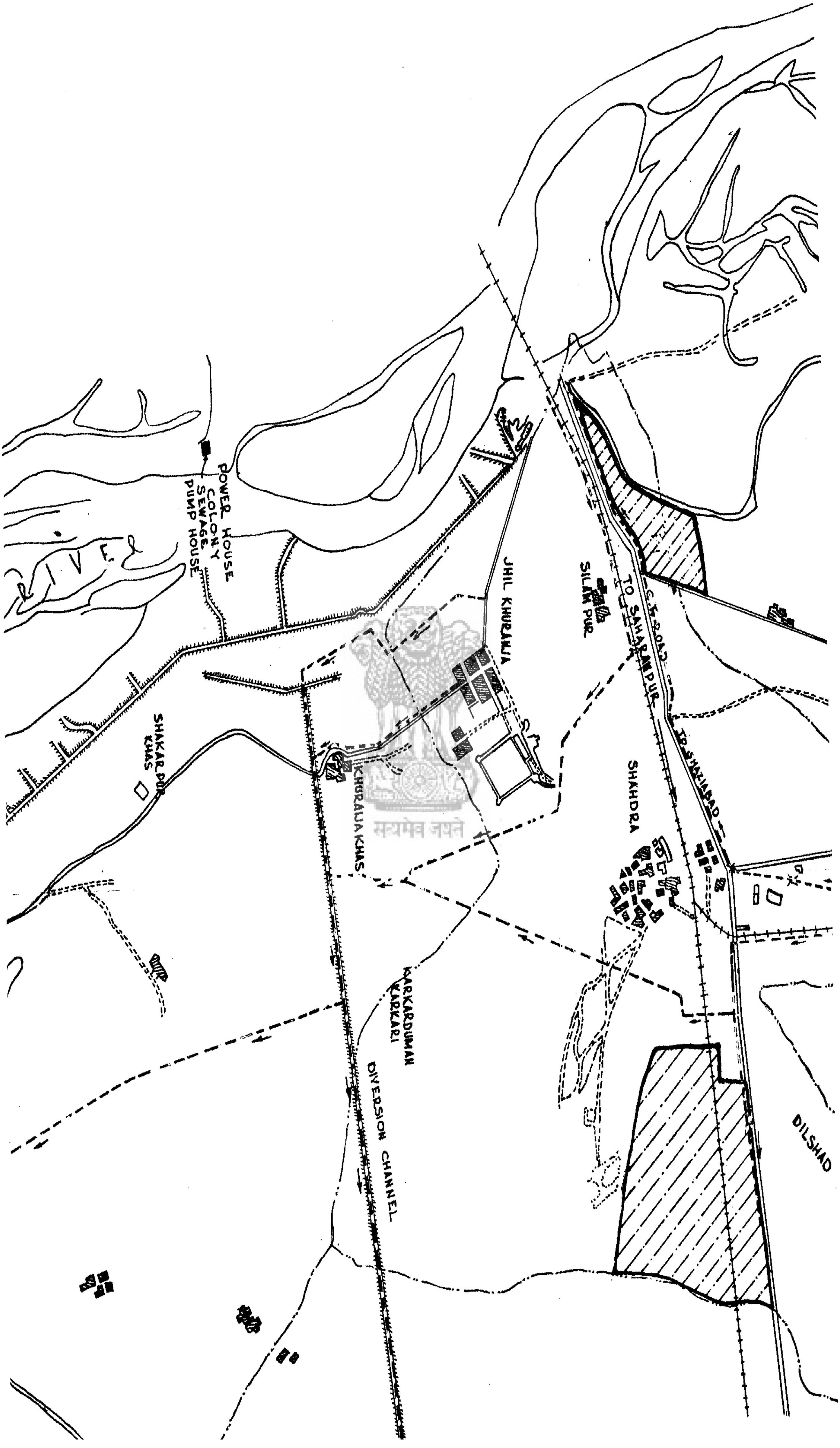
EXISTING SEWER IS SHOWN THUS ____

D.E. Ng.

SHAHDRA ZONE (BLOCK IV)

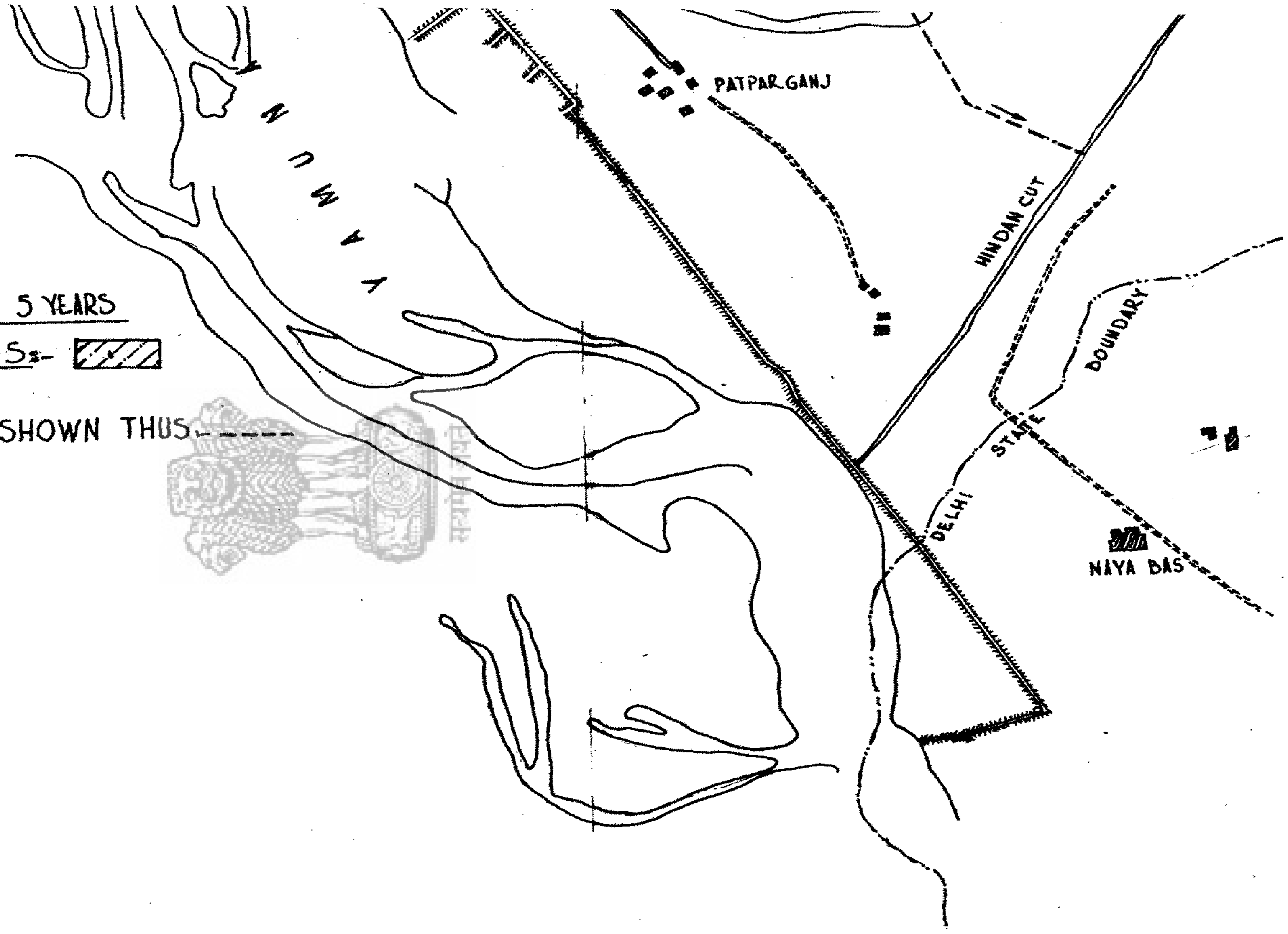
SCALE:-1½ INCHES TO 1 MILE




RIVER
POWER HOUSE COLONY SEWAGE PUMP HOUSE
JHIL KHURANJA
SILAM PUR
G.T. ROAD
TO SAHARANPUR
TO SHAHIABAD
SHAHDRA
SHAKAR PUR KHAS
KHURALJA KHAS
KARKARDUMAN KARKARI
DIVERSION CHANNEL
DILSHAD

AREAS EARMARKED FOR DEVELOPMENTS IN NEXT 5 YEARS
SHOWN THUS:- ▨

PROPOSED STORM WATER DRAINS SHOWN THUS:- - - - -



TRACED BY. S K

PLANS REFERRED TO IN APPENDIX V

सत्यमेव जयते

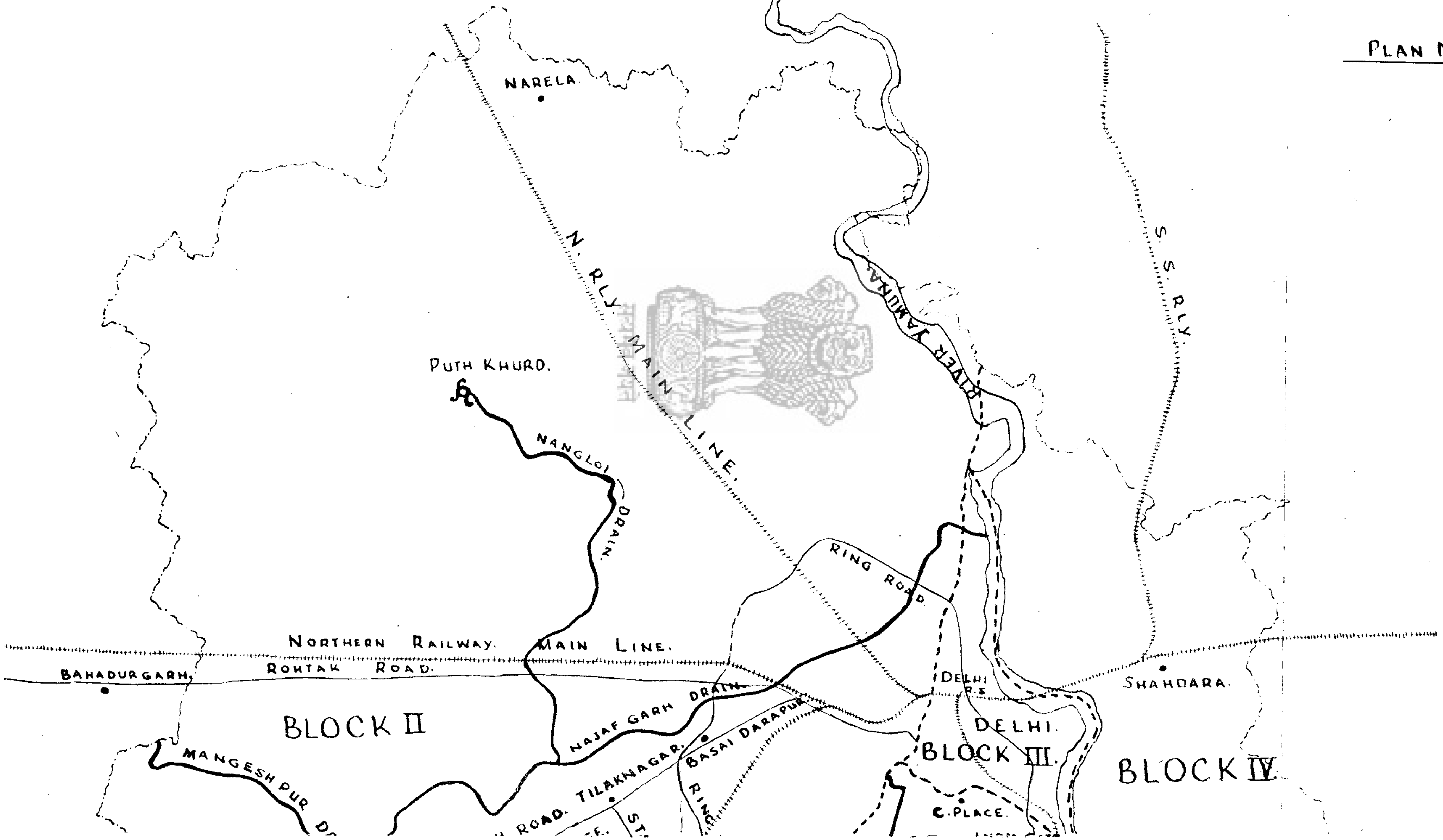
DELHI INDEX PLAN

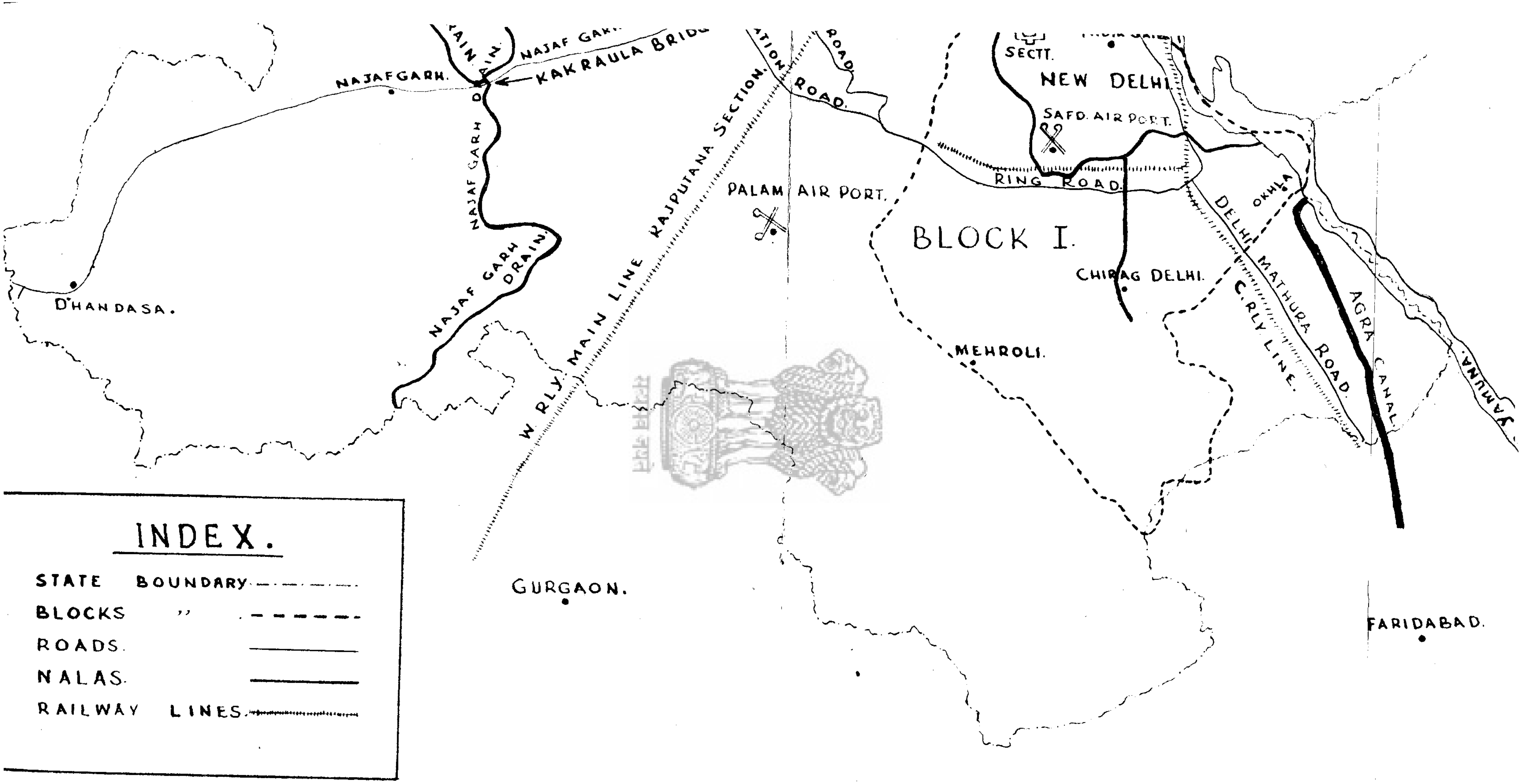
Showing

BLOCKS

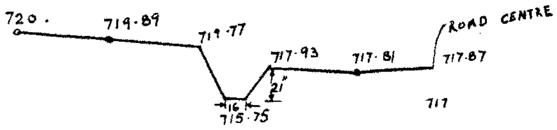
Scale:-
1 in. = 5 m

PLAN No: 1.

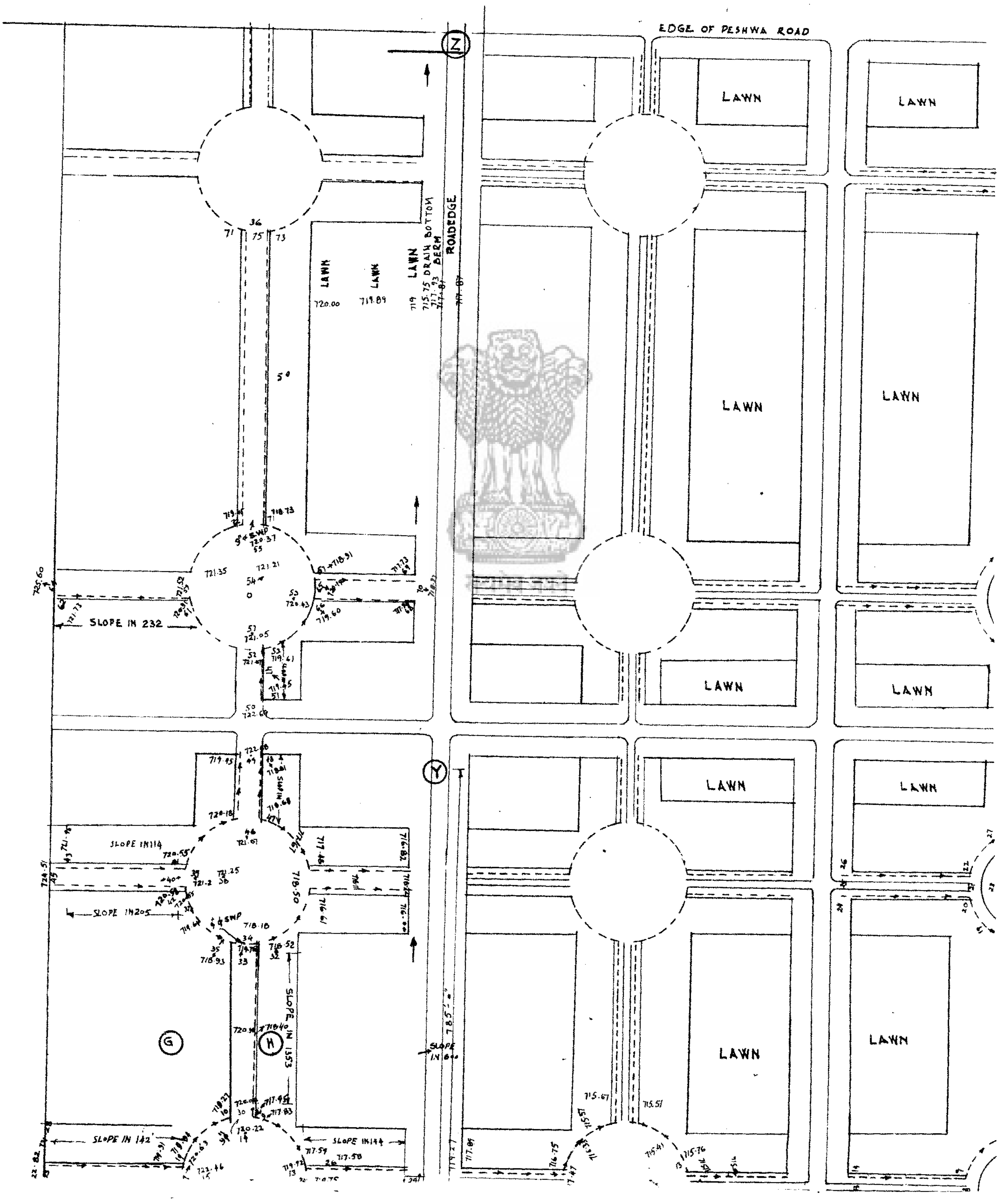



NAJAF GARH
NAJAFGARH.
KAKRAULA BRIDG
NAJAF GARH DRAIN
NAJAF GARH DRAIN.
DHANDASA.
W. RLY. MAIN LINE RAJPUTANA SECTION.
ATION ROAD.
ROAD
PALAM AIR PORT.
SECTT.
NEW DELHI
SAFD. AIR PORT.
RING ROAD.
BLOCK I.
CHIRAG DELHI.
MEHROLI.
OKHLA
DELHI MATHURA ROAD.
C. RLY. LINE.
AGRA CANAL.
YAMUNA.
GURGAON.
FARIDABAD.
INDEX.
STATE BOUNDARY
BLOCKS ,,
ROADS.
NALAS.
RAILWAY LINES.

PLAN SHOV

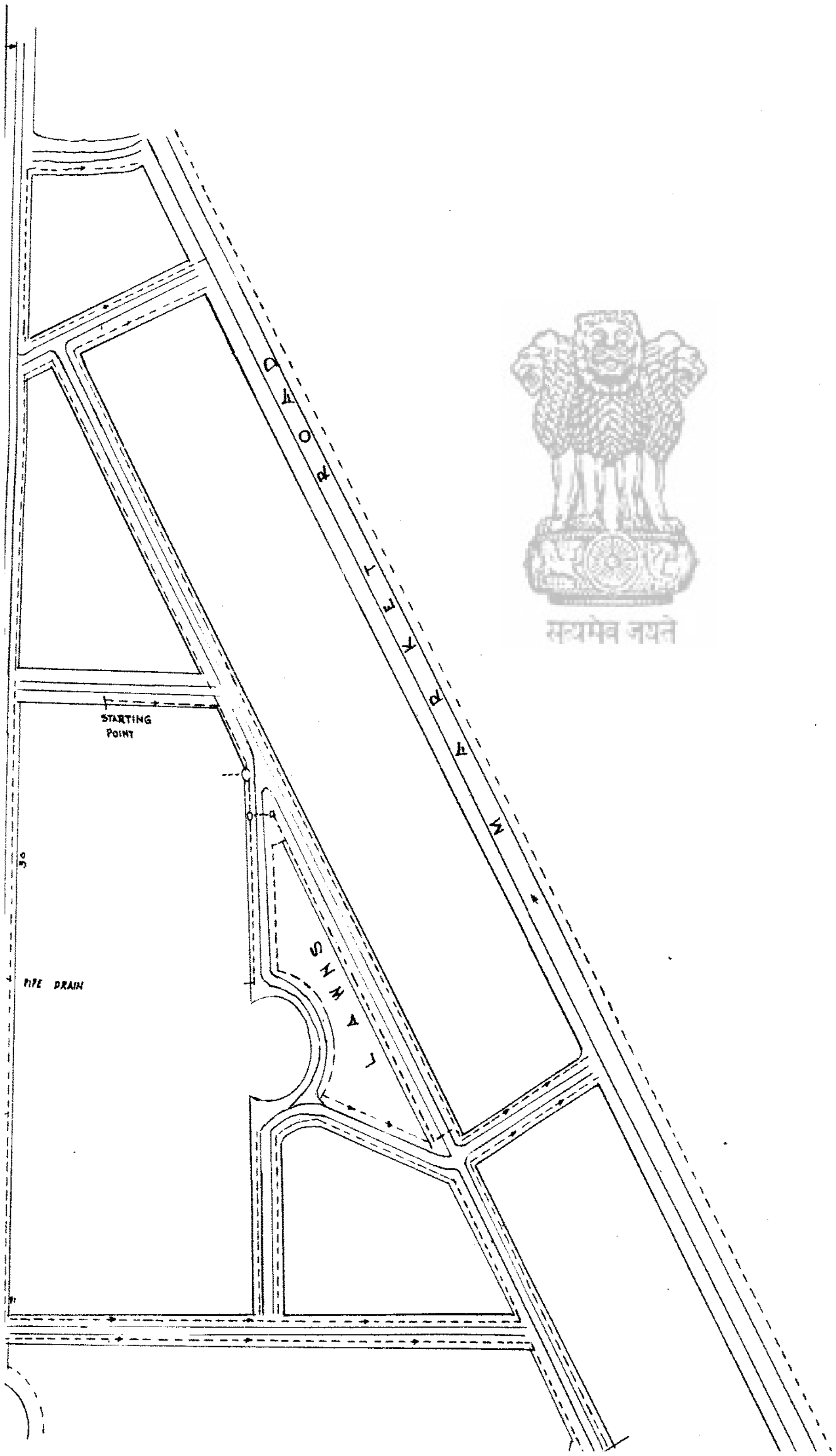


SECTION AT Z



PLAN No:-5.2
SHEET No:- 1.

NG BRANCH DRAINS ON NORTH OF DRAIN No. 1-C.

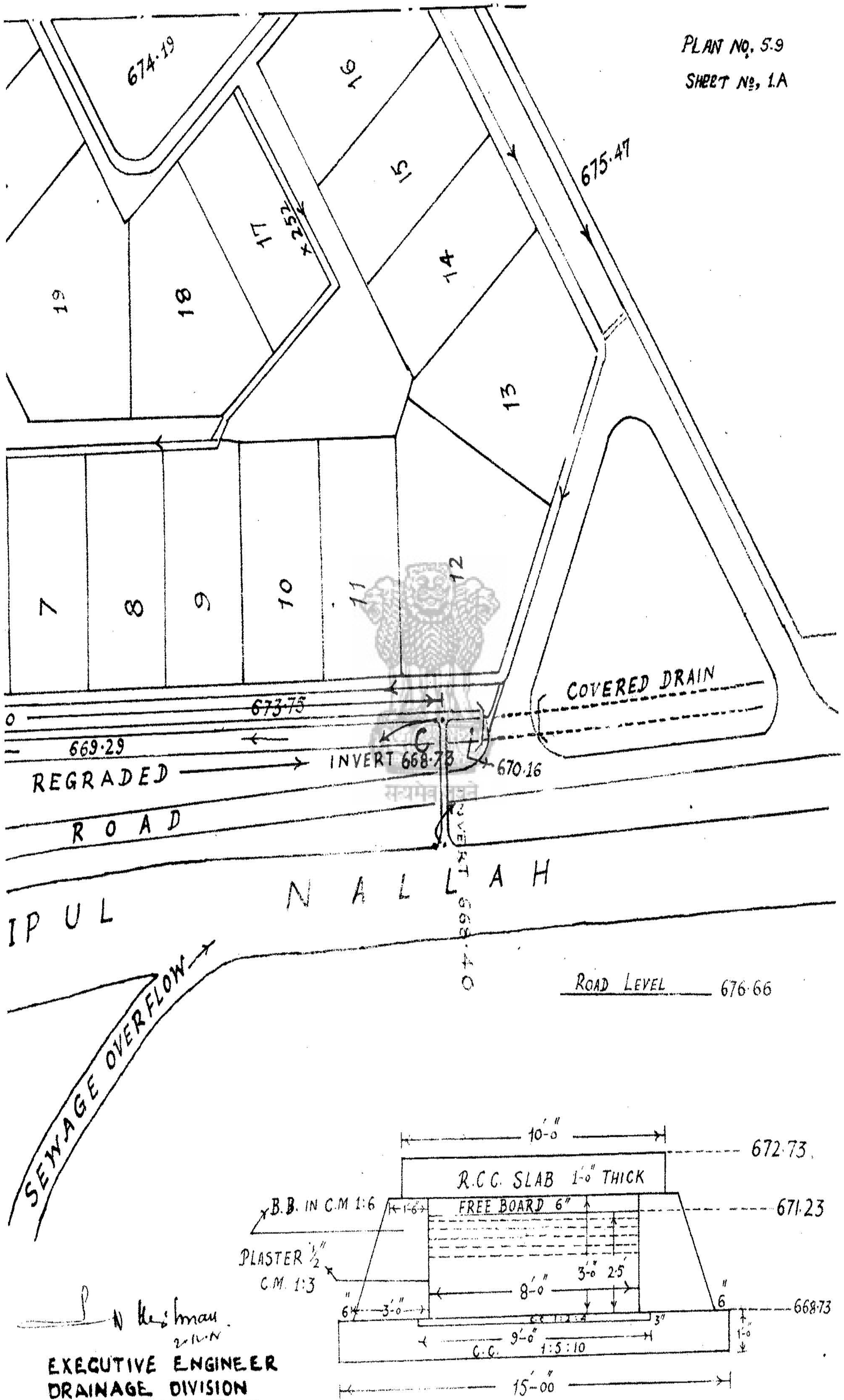


सत्यमेव जयते

REA

D.D 2
II

PLAN No. 5.9
SHEET No. 1.A



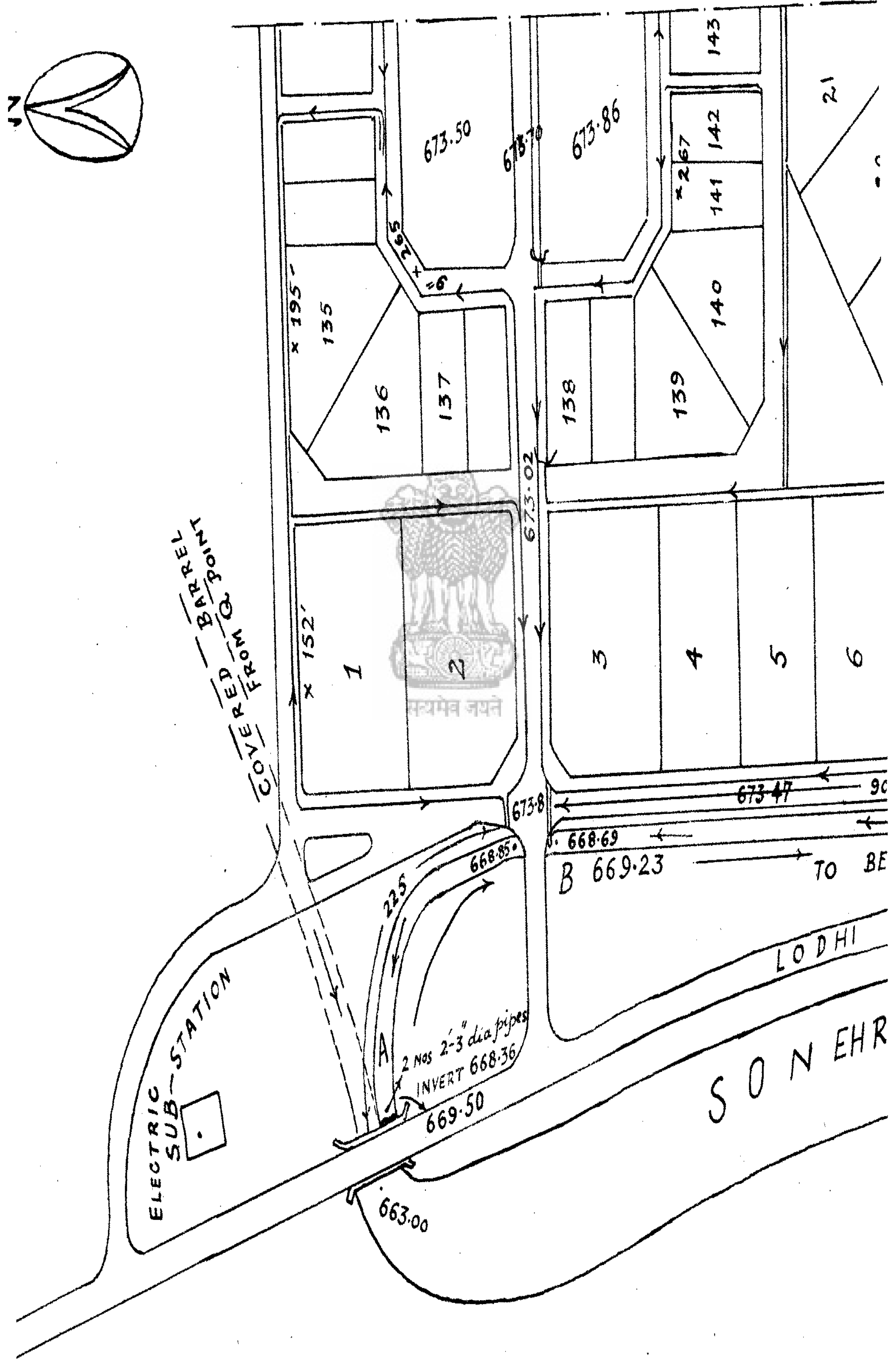
N Krishnan
2-11-N

EXECUTIVE ENGINEER
DRAINAGE DIVISION
C.P.W.D. NEWDELHI.

SECTION OF PROPOSED BARREL

GOLF COURSE A

SCALE – 1" = 100'

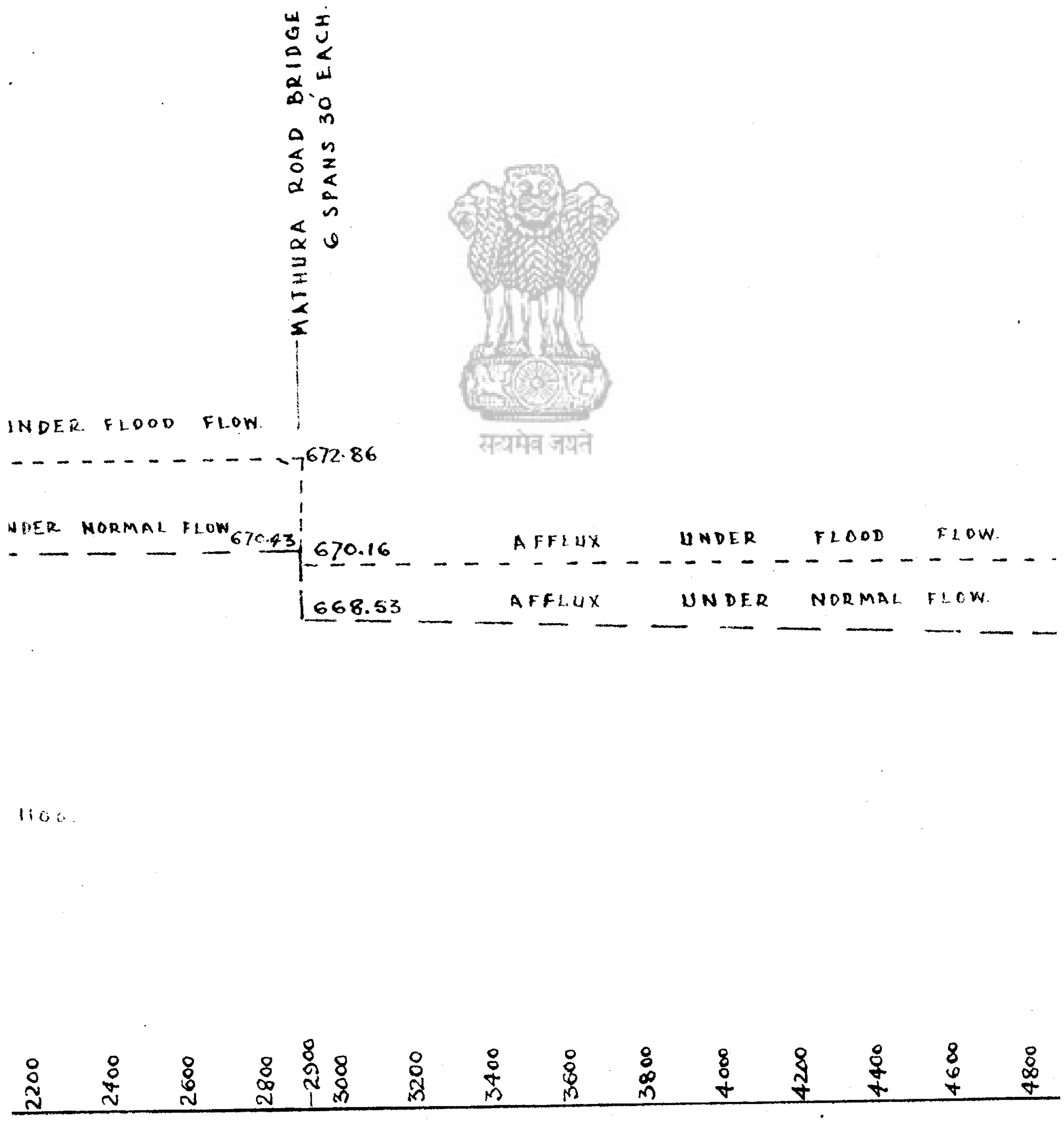


सत्यमेव जयते

L SECTION

BARAPULA NALA

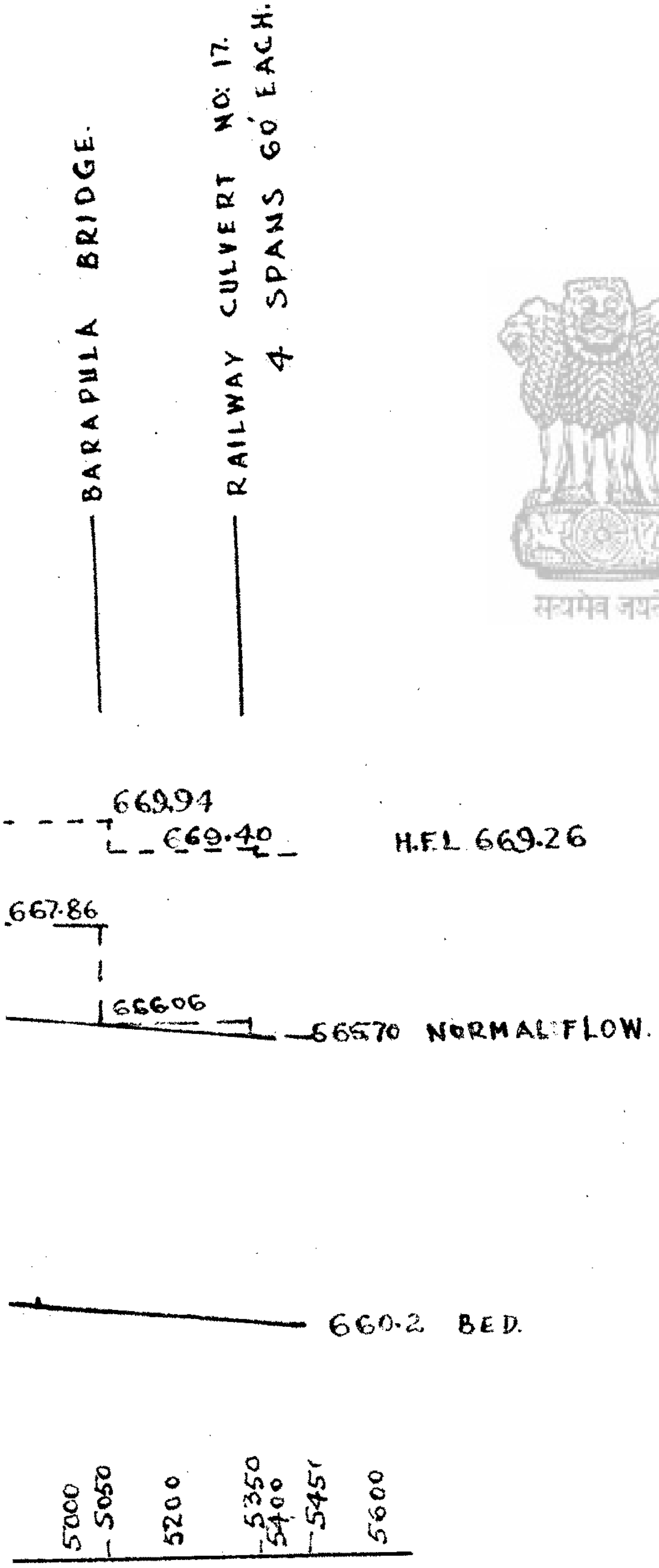
SCALE— HORIZONTAL 400′ = 1″
VERTICAL = 4′ = 1″



सत्यमेव जयते

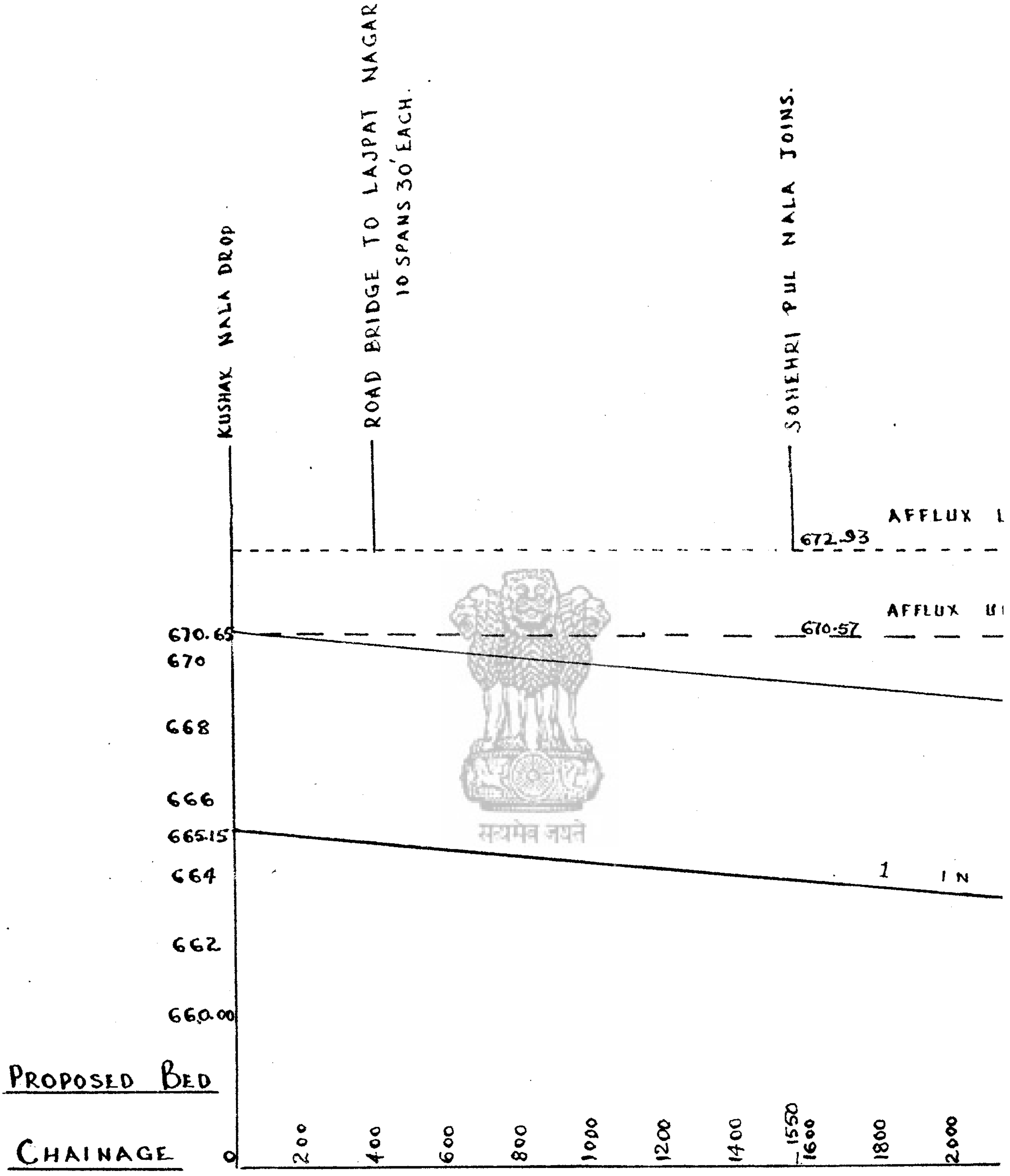
DRNG. No – DRAINAGE 1|3

PLAN No. 5.12
SHEET No. 2



सत्यमेव जयते

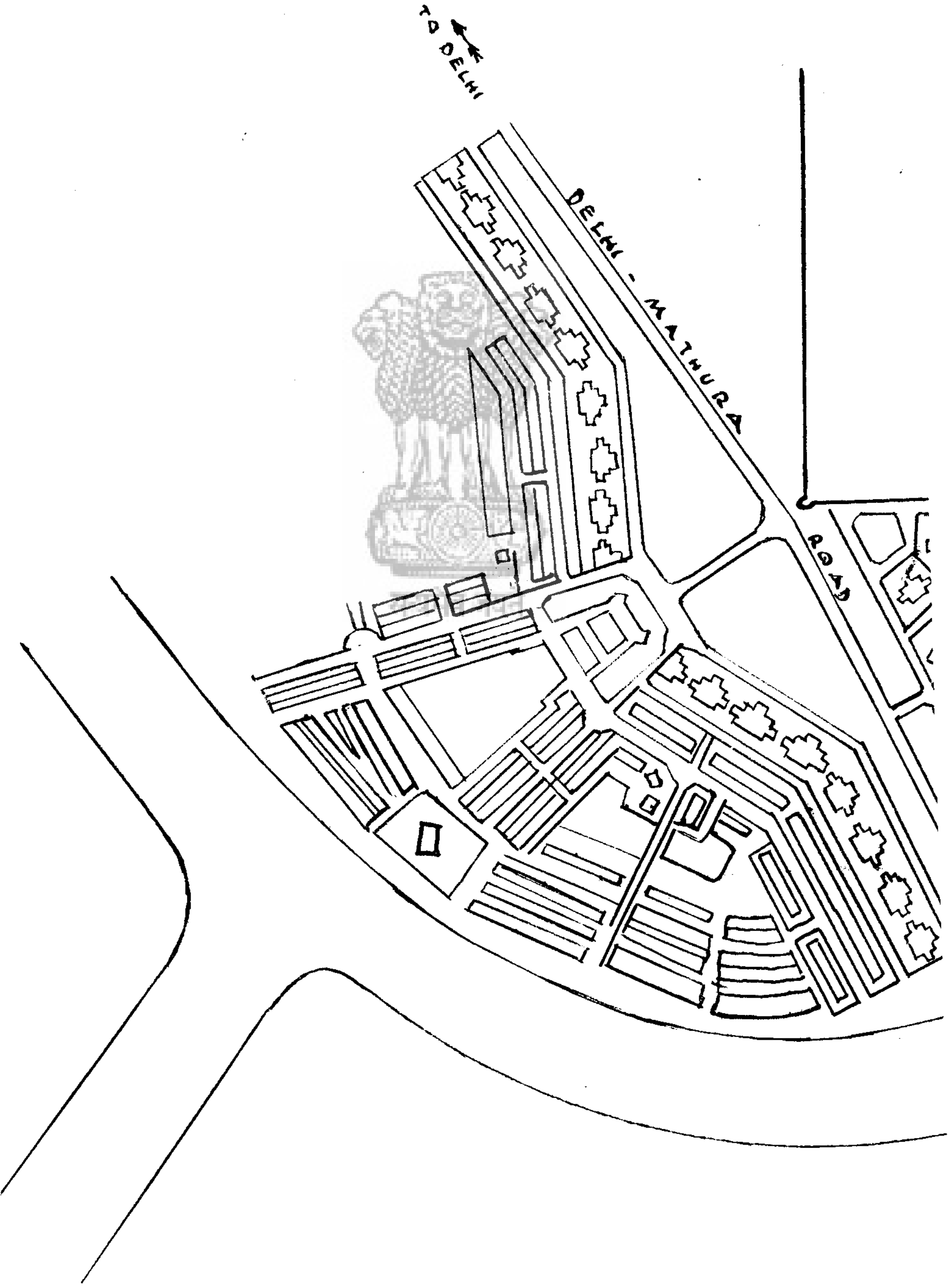
(S.N. KRISHNAN)
EXECUTIVE ENGINEER
DRAINAGE DIVISION
C.P.W.D NEW DELHI.


KUSHAK NALA DROP
ROAD BRIDGE TO LAJPAT NAGAR
10 SPANS 30' EACH.
SONEHRI PUL NALA JOINS.
AFFLUX L
672.93
AFFLUX U
670.57
670.65
670
668
666
665.15
664
662
660.00
1 IN
PROPOSED BED
CHAINAGE
0
200
400
600
800
1000
1200
1400
1550
1600
1800
2000

सत्यमेव जयते

LAY-OUT PLAN SHOWING CON
WITH SUMP WELL AND PUMPING
OF FLOODING OF NIZAMUDI

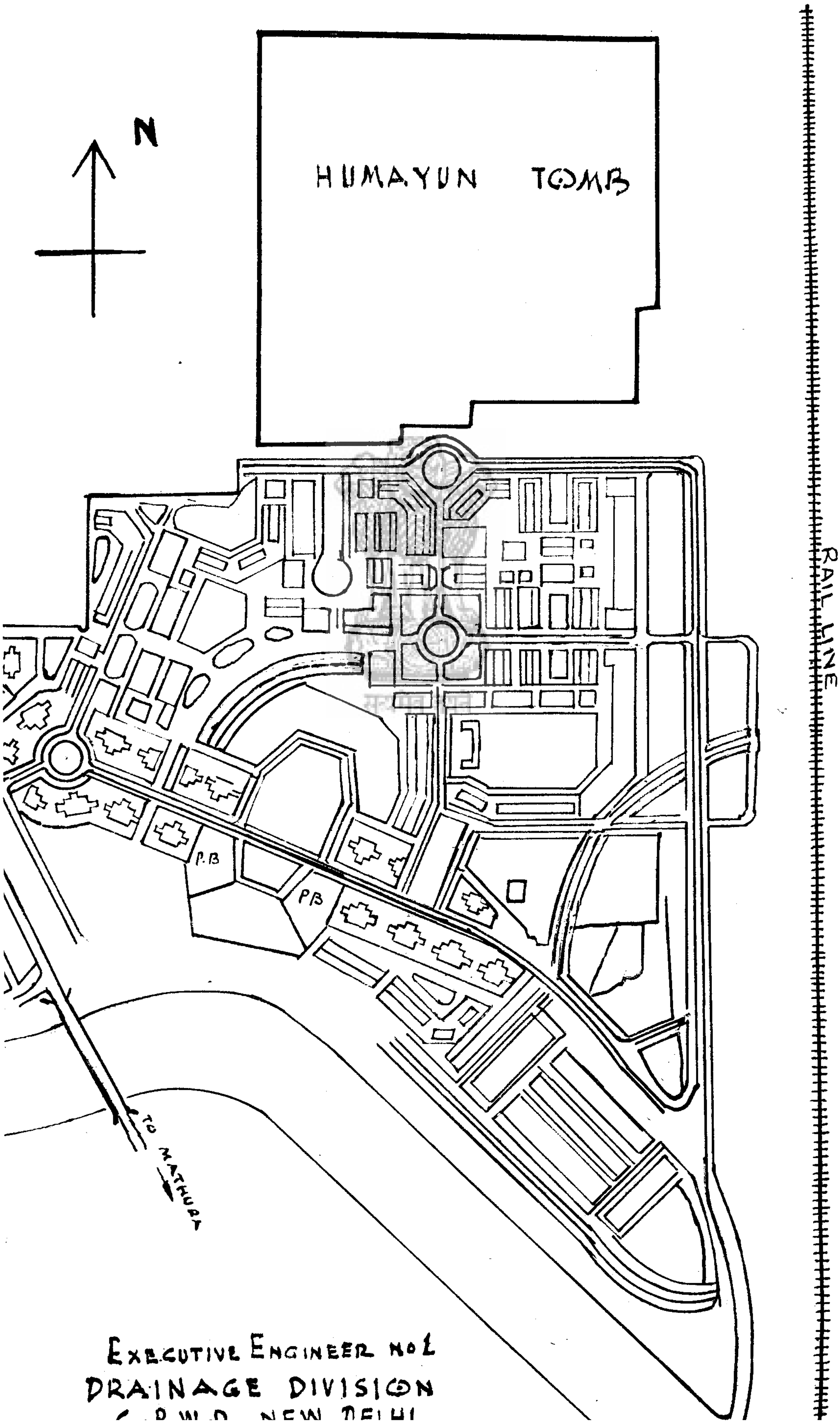
SCALE : 400 FT = 1 INCH



ASSTT. ENGINEER NO IV
DRAINAGE DIVISION
C P W D NEW DELHI

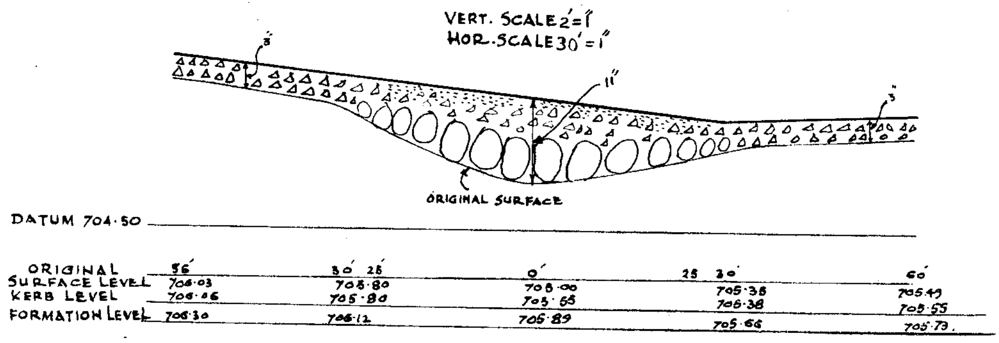
PLAN NO. 5.10

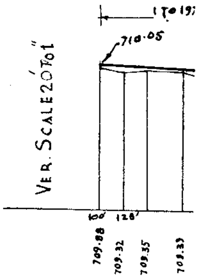
STRUCTION OF S.W. DRAIN
PLANT FOR PREVENTION
IN AREA

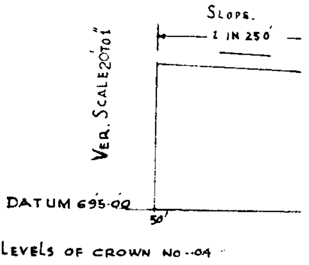


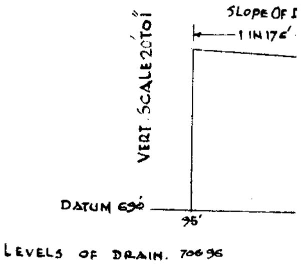
EXECUTIVE ENGINEER NO 1
DRAINAGE DIVISION
C.P.W.D. NEW DELHI

DETAIL OF CYCLE TRACK AT POINT P. L. SECTION

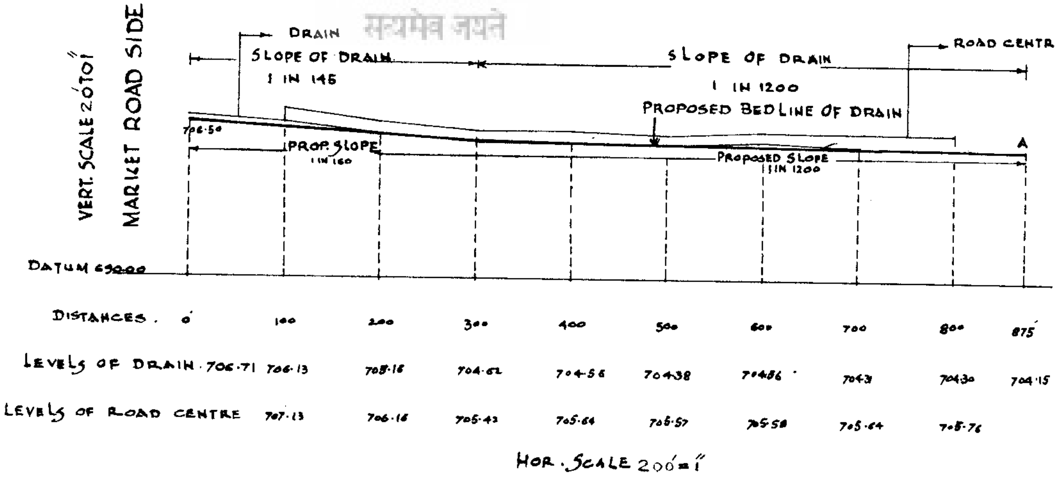

VERT. SCALE 2'=1"
HOR. SCALE 30'=1"
3"
11"
3"
ORIGINAL SURFACE
DATUM 704·50
ORIGINAL SURFACE LEVEL 56' 706·03 30' 25' 705·80 0' 705·00 25 30' 705·38 60' 705·49
KERB LEVEL 706·46 705·80 705·55 705·38 705·55
FORMATION LEVEL 706·30 706·12 705·89 705·66 705·73.

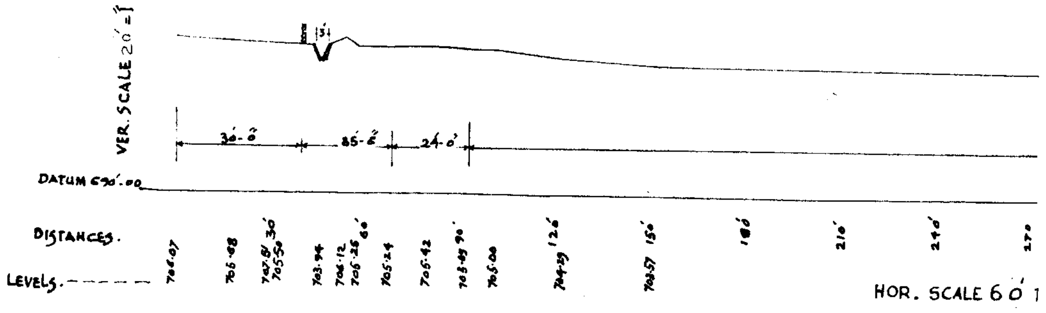




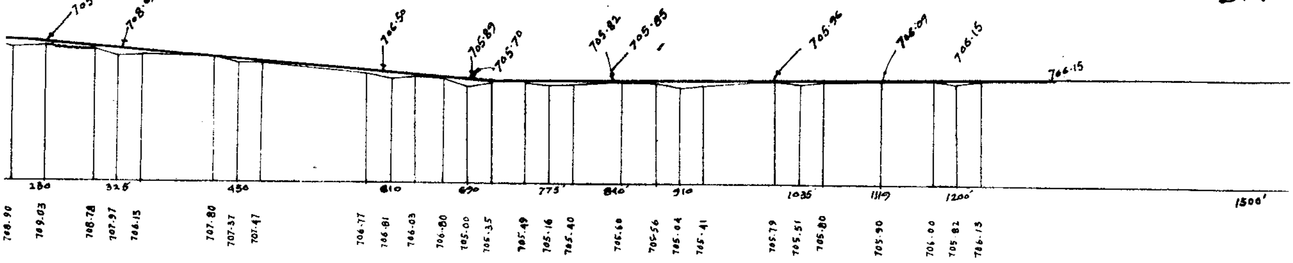


LONGITUDINAL SECTION OF PUCCA DRAIN ALONG BAIRD LANE AND " " OF BAIRD ROAD LANE


VERT. SCALE 20' TO 1"
MARKET ROAD SIDE
DRAIN
SLOPE OF DRAIN
1 IN 145
SLOPE OF DRAIN
1 IN 1200
ROAD CENTR
PROPOSED BED LINE OF DRAIN
706·50
PROP. SLOPE 1 IN 160
PROPOSED SLOPE 1 IN 1200
A
DATUM 690·00
DISTANCES. 0' 100 200 300 400 500 600 700 800 875'
LEVELS OF DRAIN. 706·71 706·13 705·16 704·62 704·56 704·38 704·86 704·31 704·30 704·15
LEVELS OF ROAD CENTRE 707·13 706·16 705·43 705·64 705·57 705·58 705·64 705·76
HOR. SCALE 200'=1"

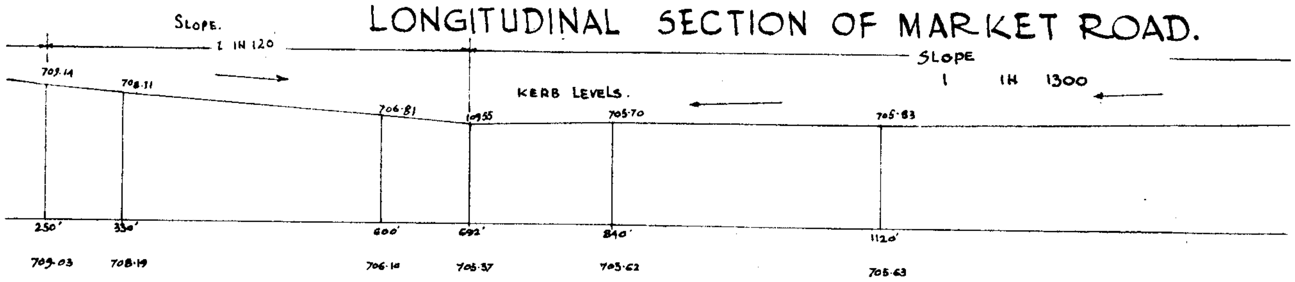

VER. SCALE 20'=1"
1'3"
30'-0"
85'-6"
24'-0"
DATUM 690'.00
DISTANCES. 30' 60' 90' 120' 150' 180' 210' 240' 270
LEVELS. 706·07 705·88 707·81 705·50 703·94 706·12 706·25 705·24 705·42 705·49 705·00 704·29 703·57
HOR. SCALE 60' 1

LONGITUDINAL SECTION OF CYCLE TRACK ON EASTERN BAN



HOR. SCALE 200 TO 1"

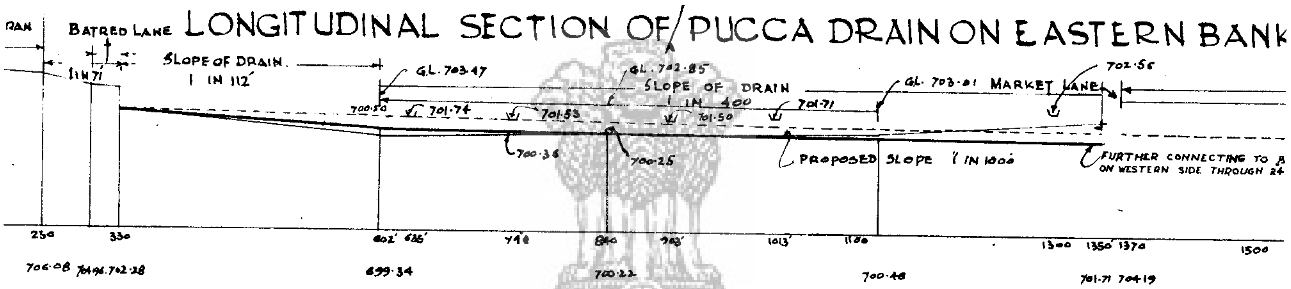
LONGITUDINAL SECTION OF MARKET ROAD.



HOR. SCALE 200 TO 1"

EXISTING.

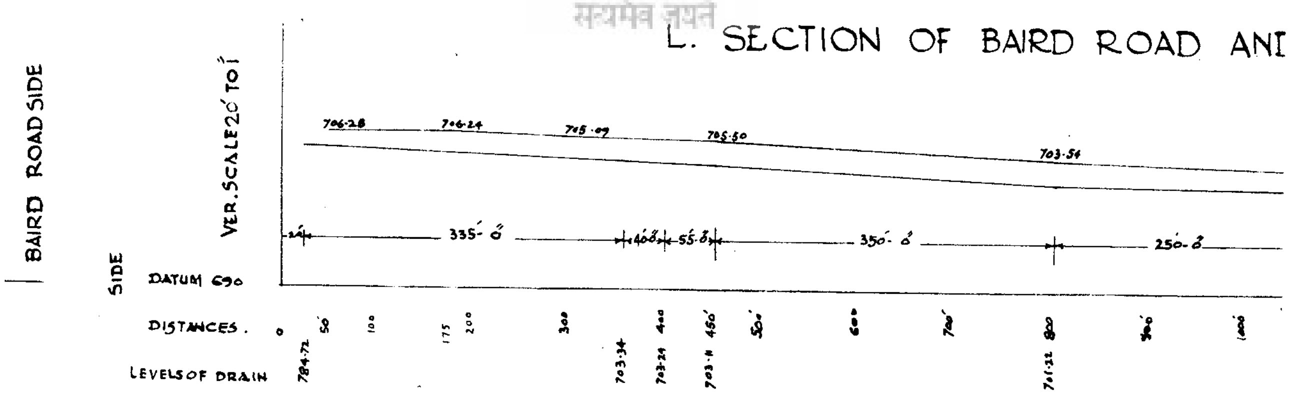
LONGITUDINAL SECTION OF PUCCA DRAIN ON EASTERN BANK



HOR. SCALE 200 TO 1"

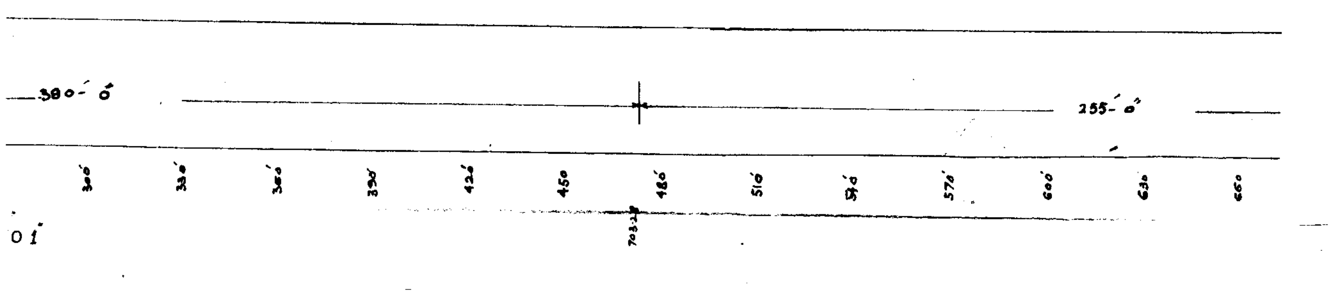
सत्यमेव जयते

L. SECTION OF BAIRD ROAD ANI



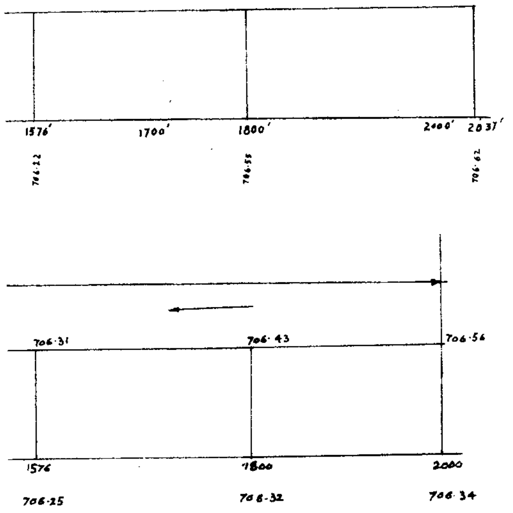
HOR. SCALE 200 TO 1"

.. SECTION AT E.F. AS SHOWN ON THE PLAN (SERVICE ROAD BETWEEN QRS. I & II)

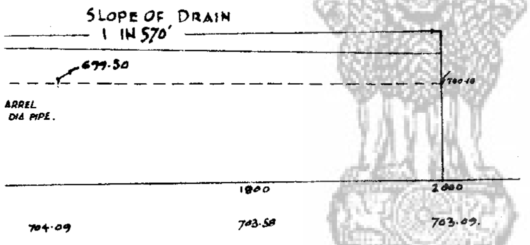


SHEET No 2
PLAN No 5.13

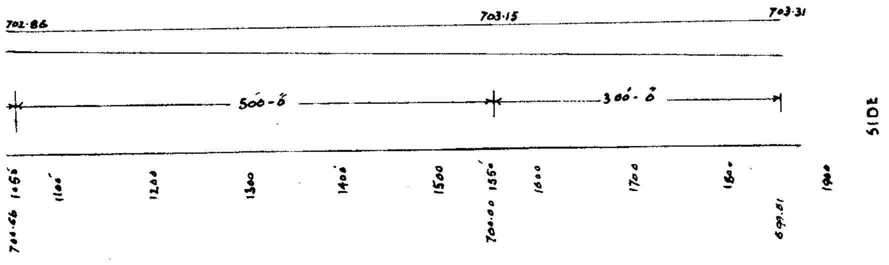
K OF MARKET ROAD.



‹ OF MARKET ROAD.



) DRAIN ON WESTERN SIDE



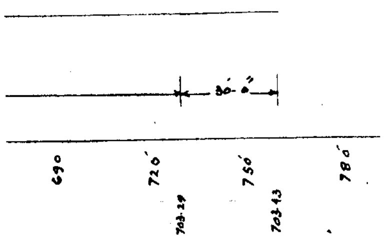
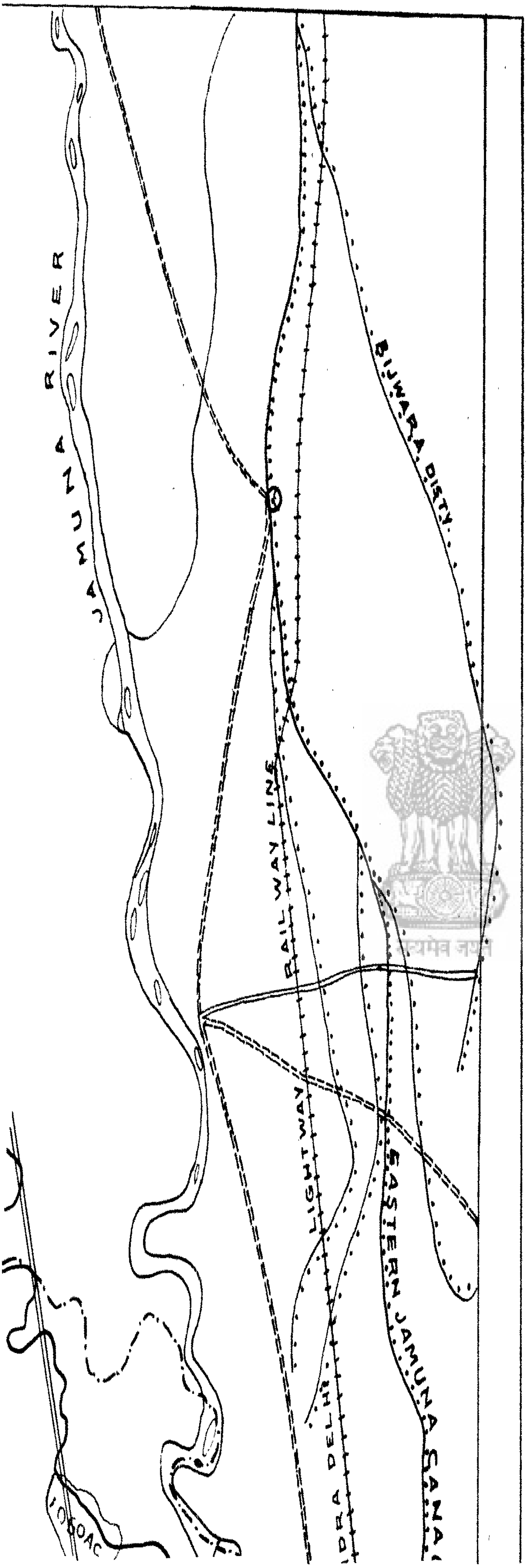


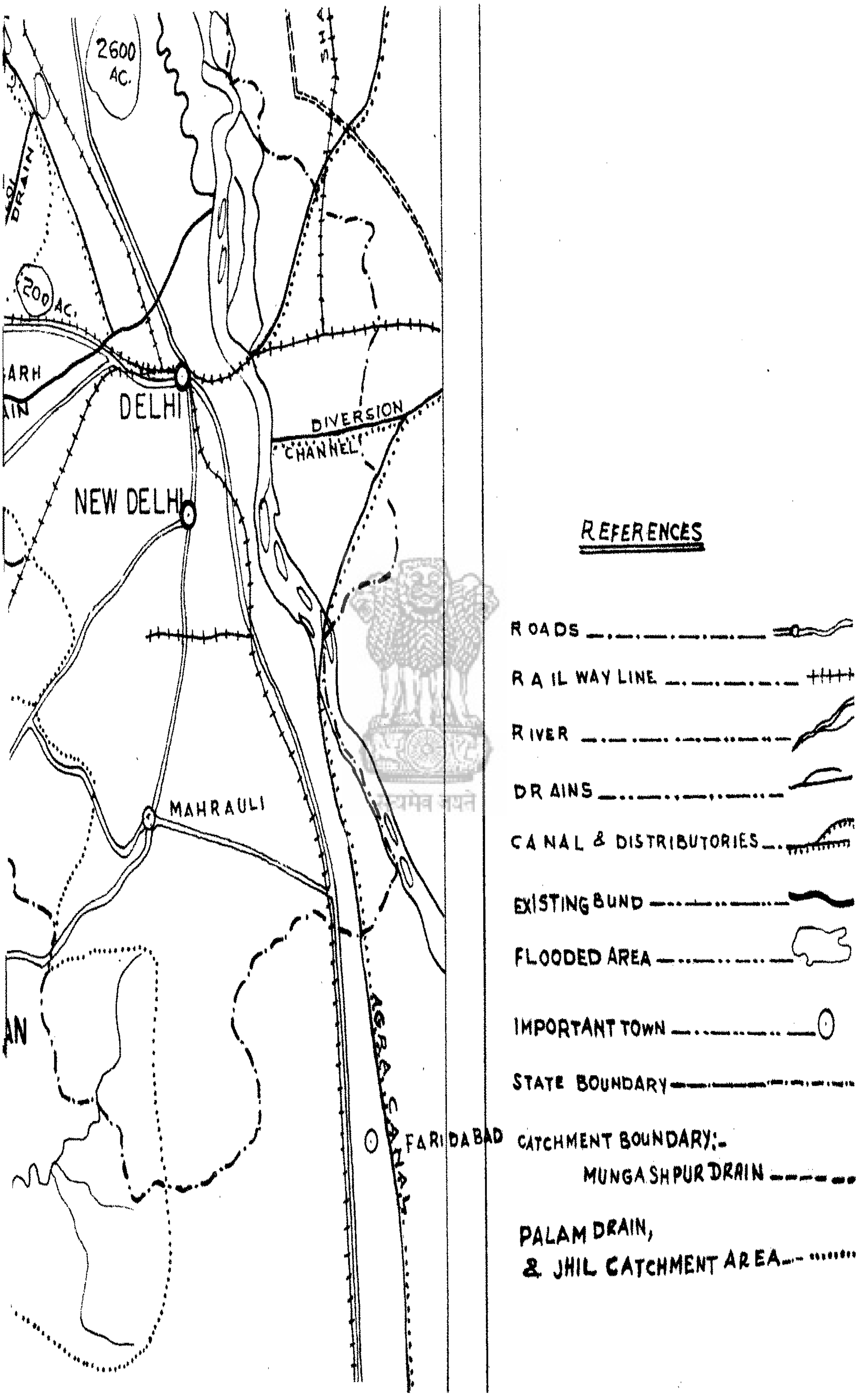
EXHIBIT No.

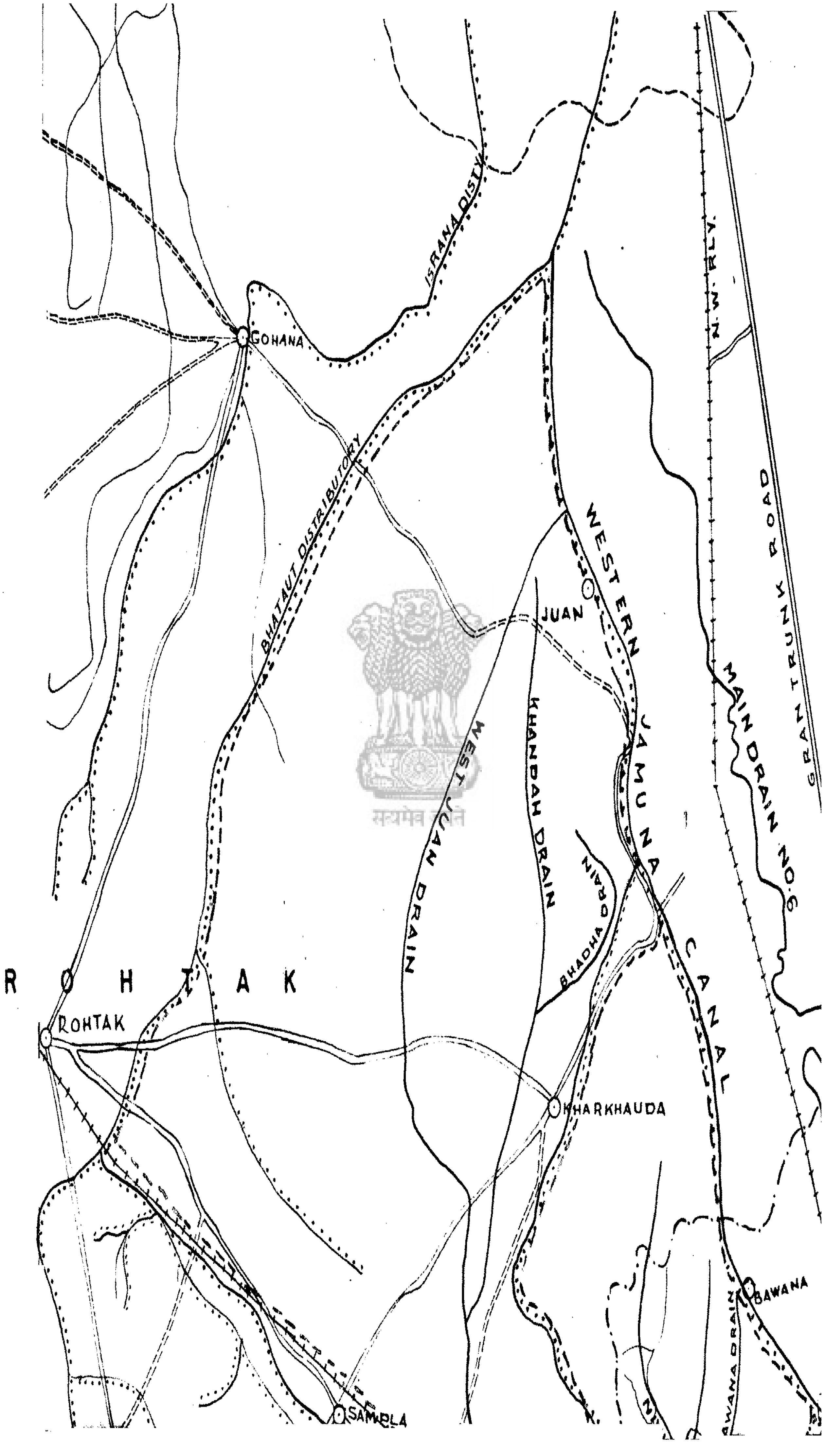


सत्यमेव जयते

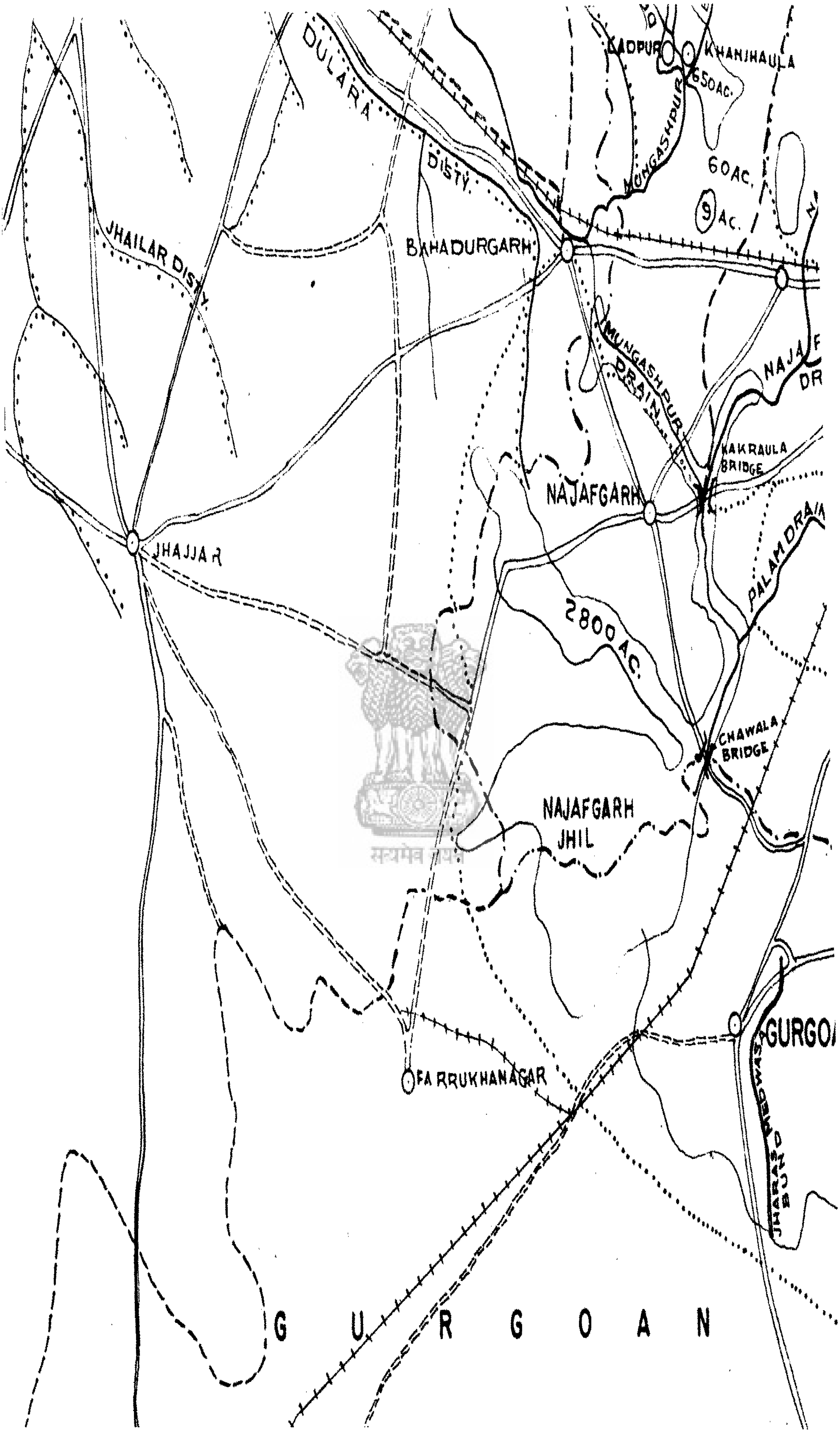
SITE PLAN OF NAJAFGARH DRAINAGE SYSTEM

SCALE 1" = 4 MILES


2600 AC.
DRAIN
200 AC.
ARH
AIN
DELHI
NEW DELHI
DIVERSION
CHANNEL
MAHRAULI
AN
FARIDABAD
AGRA CANAL
REFERENCES
ROADS
RAILWAY LINE
RIVER
DRAINS
CANAL & DISTRIBUTORIES
EXISTING BUND
FLOODED AREA
IMPORTANT TOWN
STATE BOUNDARY
CATCHMENT BOUNDARY:-
MUNGASHPUR DRAIN
PALAM DRAIN,
& JHIL CATCHMENT AREA

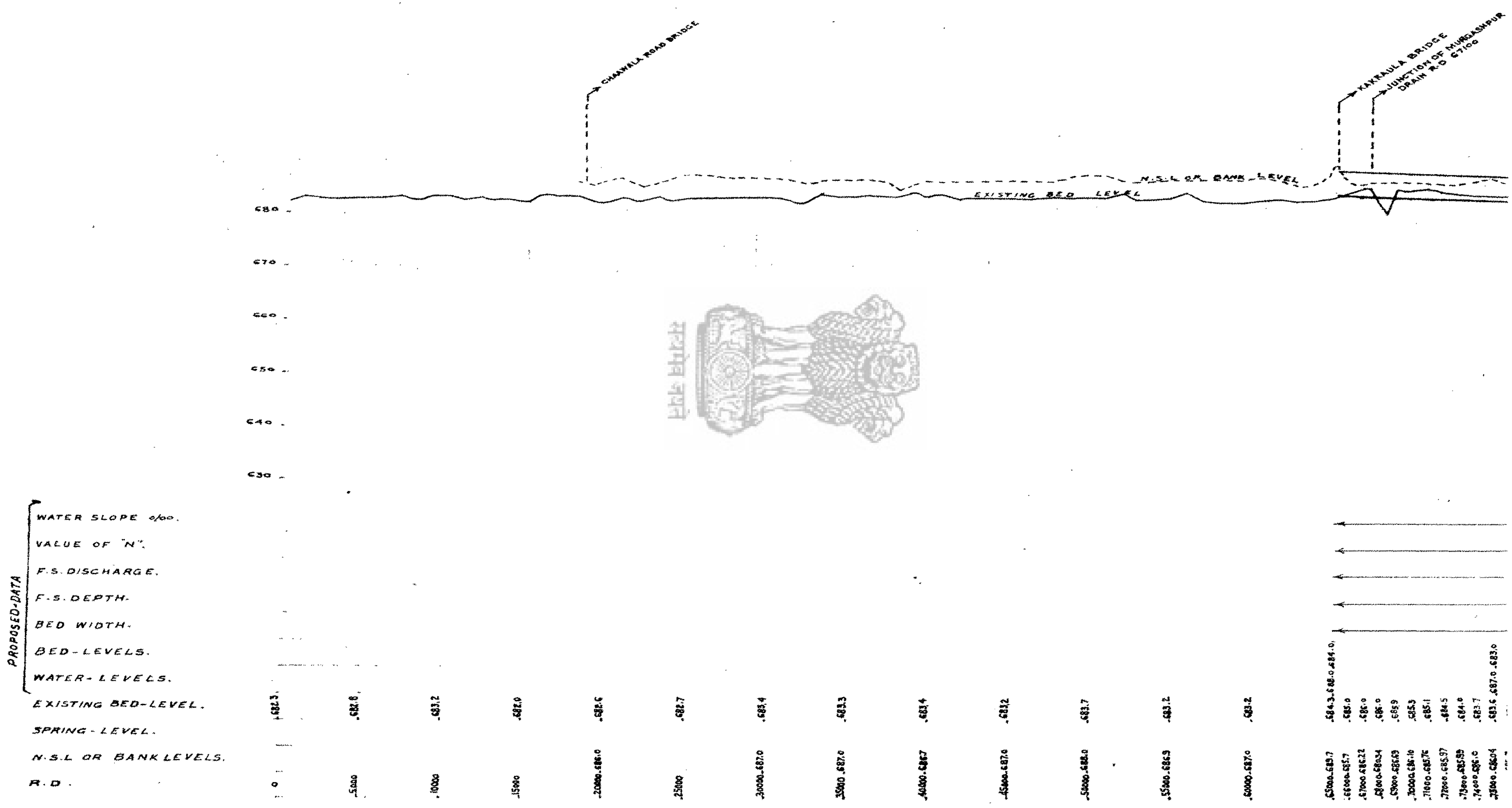

ISRANA DISTY.
GOHANA
BHATAUT DISTRIBUTORY
N.W. RLY.
GRAND TRUNK ROAD
JUAN
WESTERN JAMUNA CANAL
MAIN DRAIN No. 6
WEST JUAN DRAIN
KHANDAH DRAIN
BHADHA DRAIN
ROHTAK
ROHTAK
KHARKHAUDA
BAWANA
BAWANA DRAIN
SAMPLA

सत्यमेव जयते


DULARA DISTY.
JHAILAR DISTY
BAHADURGARH
KADPUR
KHANJHAULA
650 AC.
MUNGASHPUR
60 AC.
9 AC.
MUNGASHPUR DRAIN
NAJAF DR
KAKRAULA BRIDGE
NAJAFGARH
PALAM DRA
JHAJJAR
2800 AC.
CHAWALA BRIDGE
NAJAFGARH JHIL
FARRUKHANAGAR
GURGO
JHARSA BUND
G U R G O A N

सत्यमेव जयते

L_SECTION OF N
(INTERIN
SCALE H/V



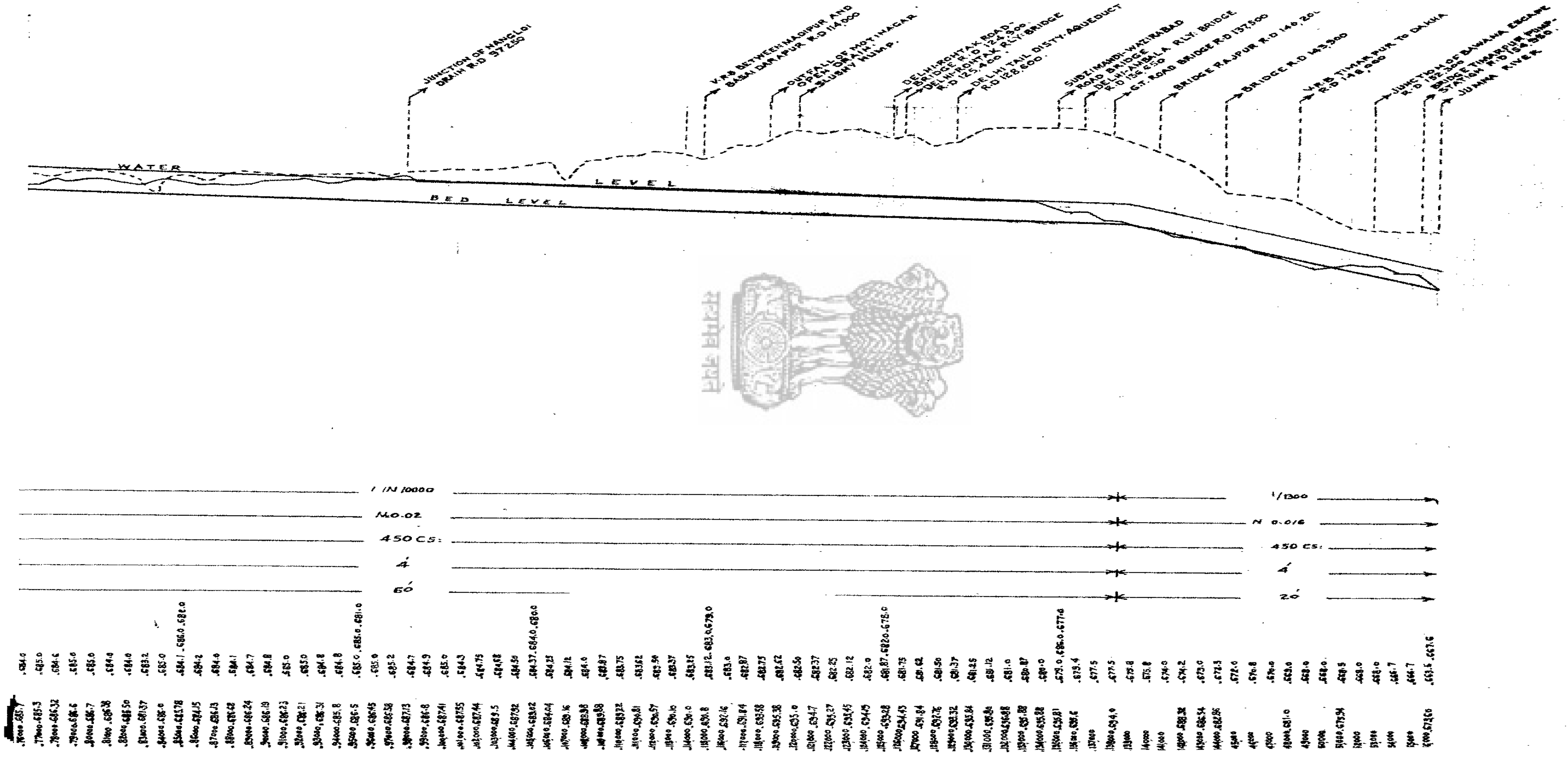
NAJAFGARH DRAIN

IM SCHEME)

HOR: 1" = 10000'

VERT: 1" = 20'

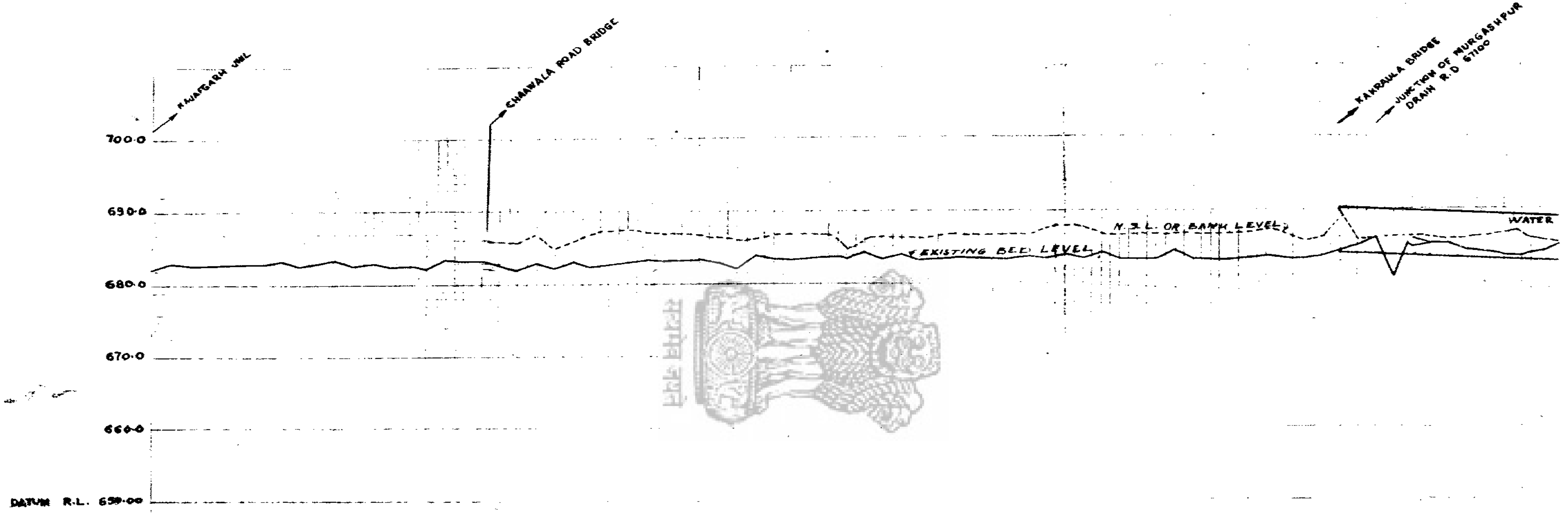
EXHIBIT No 6.


JUNCTION OF NANGLOI DRAIN R.D 97250
V.R.B BETWEEN MADIPUR AND BASAI DARAPUR R.D 114,000
OUTFALL OF MOTI NAGAR OPEN DRAIN.
SLUSHY HUMP.
DELHI-ROHTAK ROAD-BRIDGE R.D 124,900
DELHI-ROHTAK RLY. BRIDGE R.D 125,400
DELHI TAIL DISTY. AQUEDUCT R.D 128,600.
SUBZIMANDI-WAZIRABAD ROAD BRIDGE
DELHI-AMBALA RLY. BRIDGE R.D 136,650
G.T. ROAD BRIDGE R.D 137,500
BRIDGE RAJPUR R.D 140,200
BRIDGE R.D 143,300
V.R.B TIMARPUR TO DAKHA R.D 148,060
JUNCTION OF BAWANA ESCAPE R.D 152,300
BRIDGE TIMARPUR PUMP. STATION R.D 154,050.
JUMNA RIVER
WATER LEVEL
BED LEVEL
1 IN 10000
N 0.02
450 CS.
4'
60'
1/1300
N 0.016
450 CS.
4'
20'

L - SECTION OF NAJAFGARH DRAI

REGARDING DIVERSION OF MANGASH PUR, NANGLOI D
DIVERSION OF HILLS STREAMS TO JOIN NAJAFGARH NEAR B

SCALE:- HOR: 1" =19000
VERT: 1" =20'



PROPOSED DATA
W.S. SLOPE FEET ‰
VALUE OF N
F.S. DISCHARGE (Q)
F.S. DEPTH
BED WIDTH
BED LEVEL

R.D	N.S.L. OR BANK LEVELS	SPRING LEVEL	EXISTING BED LEVELS	WATER LEVELS IN FEB
			682.30	
1000			683.0	
2000		685.0	682.8	
3000			682.8	
4000			682.7	
5000			682.8	
6000			682.9	
7000			683.2	
8000			682.6	
9000			683.0	
10000			683.2	
11000		685.2	682.6	
12000			682.9	
13000			682.6	
14000			682.5	
15000			682.0	
16000			683.5	
17000			683.2	
18000	686.8		683.2	
19000	686.7	684.5	682.6	
20000	656.0		682.0	
21000	687.0		682.8	
22000	687.0		682.3	
23000		684.0	683.0	
24000	687.0		682.6	
25000		684.6	682.7	
26000	687.0		683.0	
27000			683.2	
28000	687.0		683.1	
29000			683.2	
30000	687.0		683.4	
31000		684.0	683.0	
32000	686.00		682.0	
33000		684.1	683.8	
34000	687.0		683.5	
35000	687.0		683.3	
36000	687.0		683.5	
37000	687.0		683.7	
38000	685.0		683.6	
39000	686.7		684.1	
40000	686.7		683.4	
41000	686.7		684.0	
42000	686.5		683.4	
43000	687.0		683.3	
44000	687.0		683.4	
45000	687.0		683.2	
46000	687.0	684.6	683.4	
47000	687.0		683.3	
48000	687.0		683.7	
49000	688.0		683.5	
50000	688.0		683.7	
51000	688.0	684.6	683.4	
52000	687.0		684.0	
53000	687.0		683.2	
54000	687.0	684.6	683.2	
55000	686.9		683.2	
56000	687.0	684.5	684.6	
57000	687.0	685.0	683.5	
58000	687.0		683.0	
59000	687.0		683.0	
60000	687.0		683.2	
61000	687.6		683.7	
62000	686.7		683.1	
63000	686.0	684.9	683.1	
64000	686.2		683.6	
65000	689.7		684.3	688.0 684.0
66000	685.7		685.0	
67000	686.22		686.0	
68000	686.34		686.0	
69000	686.49		685.9	
70000	686.30		685.3	
71000	685.76		685.1	
72000	685.87		684.5	
73000	685.99		684.0	
74000	686.00		683.7	
75000	686.04		683.6	687.0 683.0
76000	685.70		684.0	
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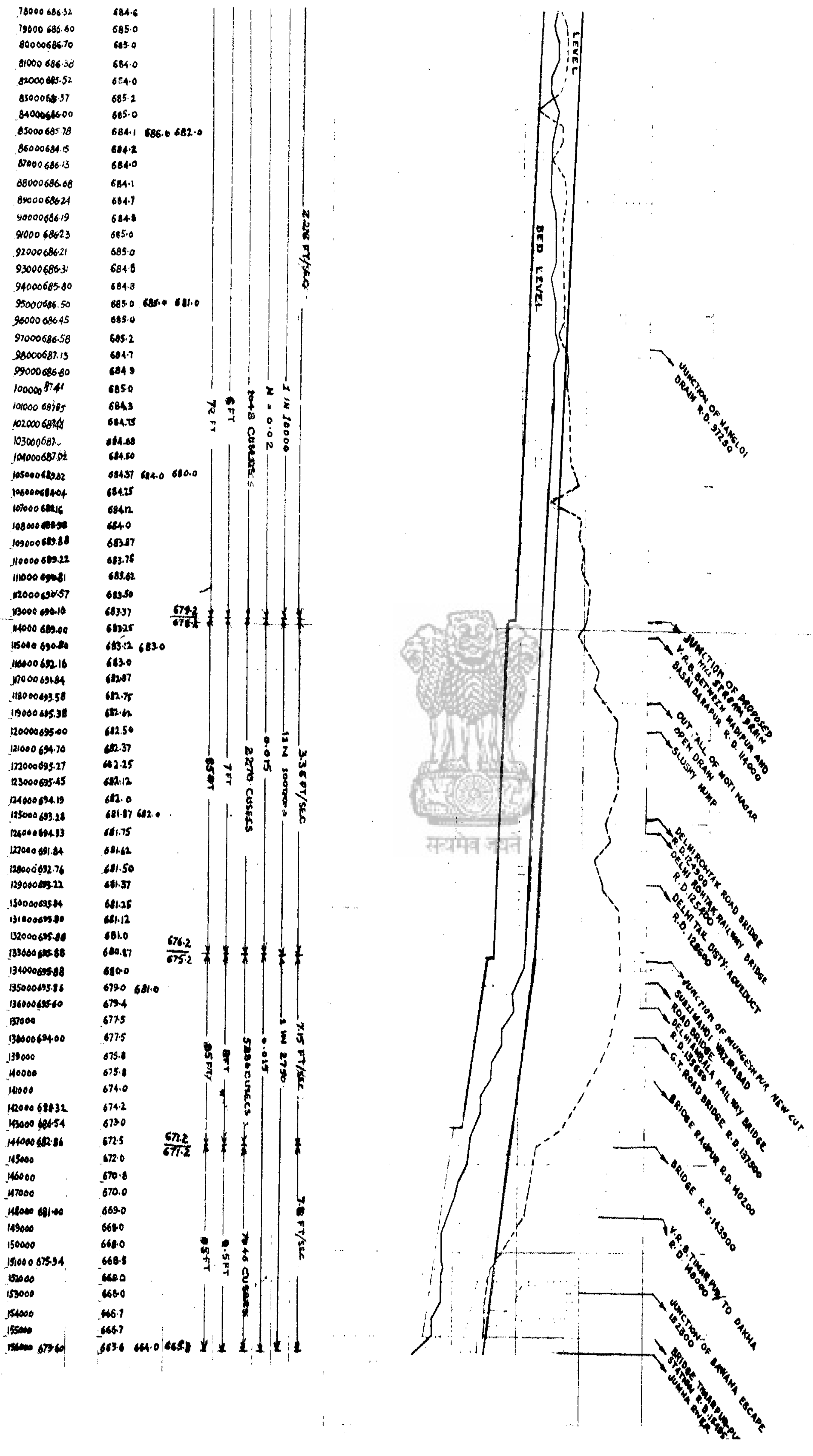
78000 686.32 684.6
79000 686.60 685.0
80000 686.70 685.0
81000 686.38 684.0
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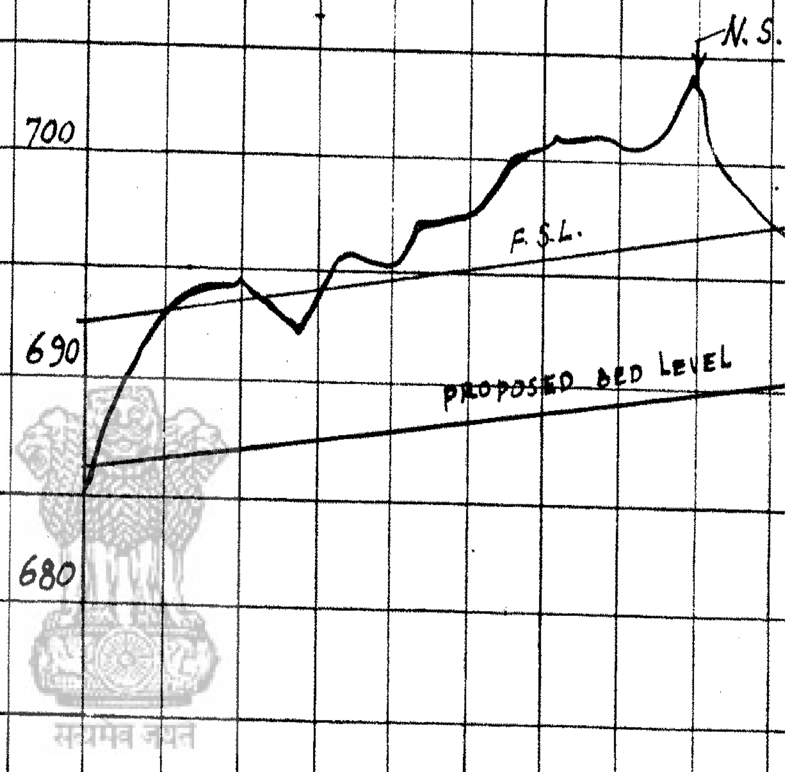
83000 685.37 685.2
84000 686.00 685.0
85000 685.78 684.1 686.0 682.0
86000 684.15 684.2
87000 686.13 684.0
88000 686.68 684.1
89000 686.24 684.7
90000 686.19 684.8
91000 686.23 685.0
92000 686.21 685.0
93000 686.31 684.8
94000 685.80 684.8
95000 686.50 685.0 685.0 681.0
96000 686.45 685.0
97000 686.58 685.2
98000 687.15 684.7
99000 686.80 684.9
100000 687.41 685.0
101000 687.85 684.3
102000 687.44 684.75
103000 687. 684.68
104000 687.92 684.50
105000 689.02 684.37 684.0 680.0
106000 684.04 684.25
107000 688.16 684.12
108000 688.98 684.0
109000 689.88 683.87
110000 689.22 683.75
111000 690.81 683.62
112000 690.57 683.50
113000 690.10 683.37
114000 689.00 683.25
115000 690.80 683.12 683.0
116000 692.16 683.0
117000 691.84 682.87
118000 693.58 682.75
119000 695.38 682.62
120000 695.40 682.50
121000 694.70 682.37
122000 695.27 682.25
123000 695.45 682.12
124000 694.19 682.0
125000 693.28 681.87 682.0
126000 694.33 681.75
127000 691.84 681.62
128000 692.76 681.50
129000 693.22 681.37
130000 695.84 681.25
131000 695.80 681.12
132000 695.88 681.0
133000 695.88 680.87
134000 695.88 680.0
135000 695.86 679.0 681.0
136000 695.60 679.4
137000 677.5
138000 694.00 677.5
139000 675.8
140000 675.8
141000 674.0
142000 688.32 674.2
143000 686.54 673.0
144000 682.86 672.5
145000 672.0
146000 670.8
147000 670.0
148000 681.00 669.0
149000 668.0
150000 668.0
151000 675.94 668.5
152000 668.0
153000 668.0
154000 666.7
155000 666.7
156000 673.60 663.6 664.0 665.8
679.2
678.2
676.2
675.2
671.2
671.2
72 FT
6 FT
1048 CUSECS
N = 0.02
1 IN 10000
2.26 FT/SEC
85 FT
7 FT
2270 CUSECS
0.015
1 IN 10000
3.36 FT/SEC
85 FT
8 FT
5286 CUSECS
0.015
1 IN 2750
7.15 FT/SEC
85 FT
9.5 FT
7946 CUSECS
7.8 FT/SEC
LEVEL
BED LEVEL
JUNCTION OF NANGLOI DRAIN R.D. 97250
JUNCTION OF PROPOSED HILL STREAM DRAIN
V.R.B. BETWEEN MADIPUR AND BASAI DARAPUR R.D. 114000
OUT FALL OF MOTI NAGAR OPEN DRAIN
SLUSHY HUMP
DELHI ROHTAK ROAD BRIDGE R.D. 124900
DELHI ROHTAK RAILWAY BRIDGE R.D. 125400
DELHI TAIL DISTY. AQUEDUCT R.D. 128600
JUNCTION OF MUNGESH PUR NEW CUT
SUBZI MANDI WAZIRABAD ROAD BRIDGE
DELHI AMBALA RAILWAY BRIDGE R.D. 135650
G.T. ROAD BRIDGE R.D. 137500
BRIDGE RAJPUR R.D. 140200
BRIDGE R.D. 143500
V.R.B. TIMARPUR TO DAKHA R.D. 148000
JUNCTION OF BAWANA ESCAPE 152300
BRIDGE TIMARPUR STATION R.D. 15485
JUMNA RIVER
RAINS
BASAI DARAPUR BRIDGE

EXHIBIT No.

L-SECTION OF HI

SCALE HORIZC

SCALE VERTICA



DATUM R.L.	670											
DESIGNED DEPTH-												
BED WIDTH												
BED-SLOPS												
FILLING.												
CUTTING.		2.8	5.1	7.1	6.9	7.0	5.8	4.6	7.4	7.7	7.0	8.9
PROPOSED-LEVELS	686.0	686.2	686.4	686.6	686.8	687.0	687.2	687.4	687.6	687.8	688.0	688.2
GROUND-LEVELS.	684.0	689.0	691.5	683.7	693.7	694.0	693.0	692.0	695.0	695.5	695.0	697.1
REDUCED DISTANCES.	0					5000					10000	

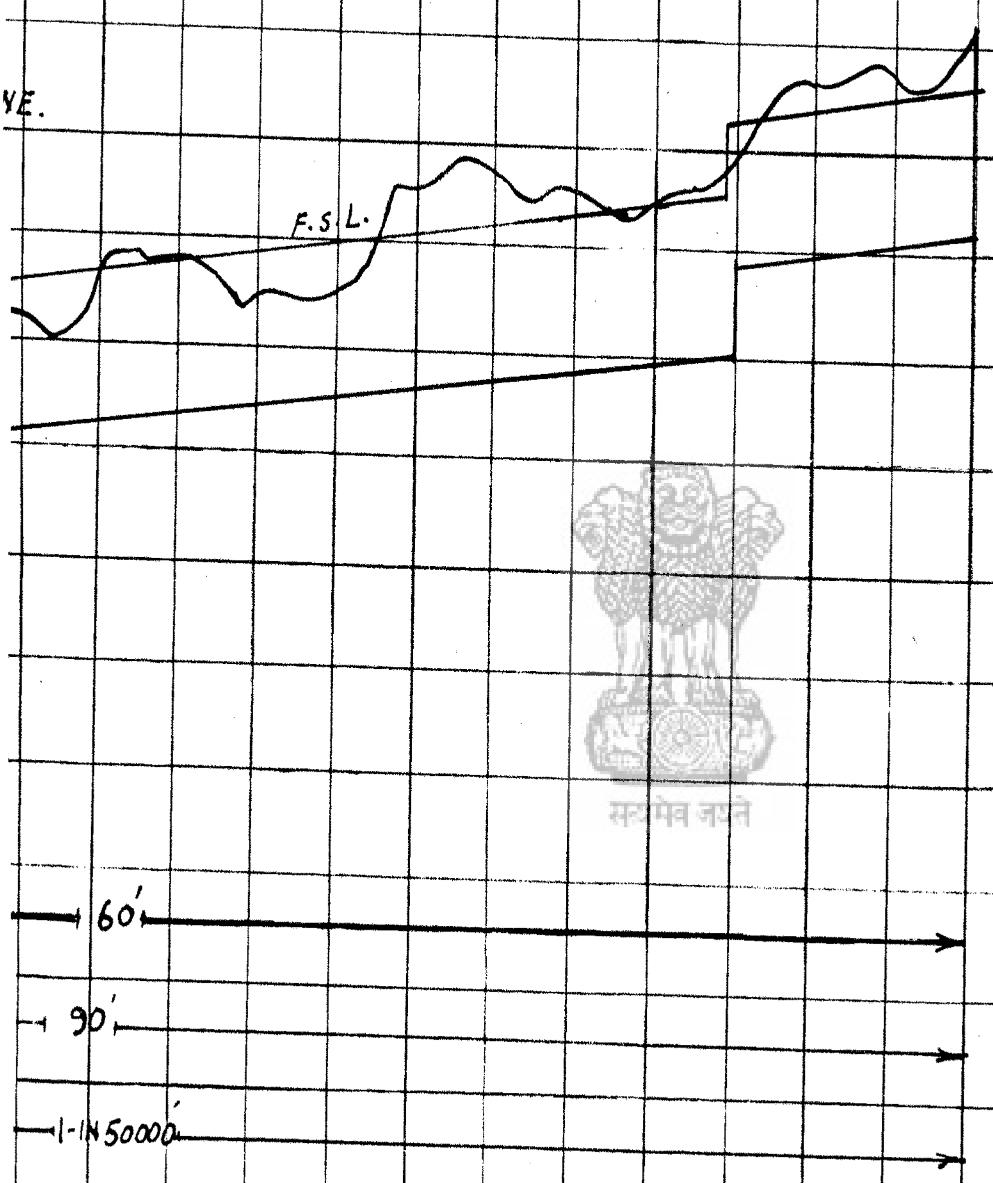
DATUM R.L.												
DESIGNED DEPTH-												
BED WIDTH												
BED-SLOPS												
FILLING.												
CUTTING.	8.6	9.0	10.6	11.2	11.4	11.1	10.6	11.0	13.5	8.9	7.1	6.0
PROPOSED-LEVELS	688.4	688.6	688.8	689.0	689.2	699.4	689.6	689.8	690.0	699.2	690.4	696.6
GROUND-LEVELS.	697.0	697.6	699.4	700.2	700.6	700.5	700.6	700.8	705.5	599.1	697.5	696.6
REDUCED DISTANCES.				15000					20000			

L STREAM DRAIN

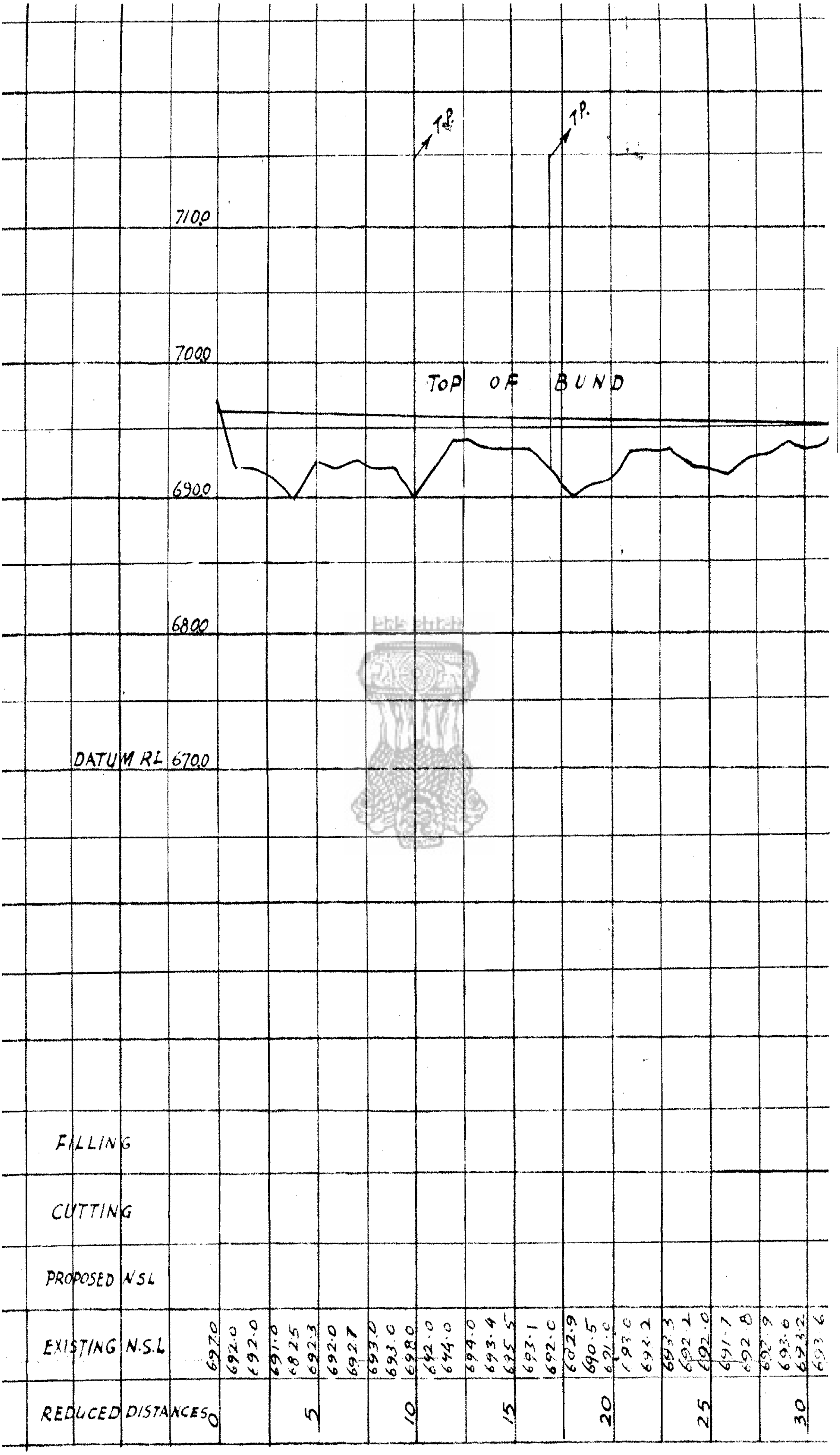
EXHIBIT No. 13.

AL 5000' FEET = 1 INCH.

10 FEET = 1 INCH.



3.2	691.2	694.4	
4.3	691.4	695.7	
7.4	691.6	699.0	
6.6	691.8	688.4	
6.3	692.0	698.3	30000
5.8	692.2	698.0	
4.0	692.4	696.4	
4.5	692.6	697.1	
3.7	692.8	696.5	
4.0	693.0	697.0	35000
5.2	693.2	698.4	
8.7	693.4	702.1	
8.6	693.6	702.2	
9.8	693.8	703.6	
8.5	694.0	702.5	40000
7.4	694.2	701.6	
7.6	694.4	702.0	
6.9	694.6	701.5	
5.5	694.8	700.3	
3.4	695.0	701.4	45000
6.8	696.2	702.0	
7.0	695.4	702.4	
5.4	699.6	705.0	
7.2	699.8	707.0	
7.0	700.0	707.0	50000
7.1	700.2	707.3	
8.1	700.4	708.5	
6.3	700.6	706.9	
6.2	700.8	707.0	
9.0	701.0	710.0	55000


TP.
TP.
7100.0
7000.0
TOP OF BUND
6900
6800
DATUM RL 6700
FILLING
CUTTING
PROPOSED NSL
EXISTING N.S.L
697.0
692.0
692.0
691.0
682.5
692.3
692.0
692.7
693.0
693.0
698.0
642.0
644.0
694.0
693.4
695.5
693.1
692.0
602.9
690.5
691.0
693.0
693.2
693.3
692.2
692.0
691.7
692.8
692.9
693.0
693.2
693.6
REDUCED DISTANCES
0
5
10
15
20
25
30

ƆN OF BUND NO 2.

EXHIBIT No. 9.